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Electrical Experimenter

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EXPERIMENTERS!

The "Electro" Codophone

(Patents Pending)

Now that we are for the time being, deprived of using our Radio outfits, it behooves us as good Americans to become proficient in learning the Wireless as well as Telegraph Codes. Operators who know the Code are, and will be, in ever rising demand. The Army and Navy need thousands of operators right now.

So far the Government has not been able to obtain any way near all the operators it requires. Not alone does the Federal Government call for thousands and thousands of operators for the army and navy, but nearly all of our many states require operators for the militia. Here is the great opportunity of a life time for you.

Would you rather fight in the trenches, or punch the key behind the lines? Either way you benefit your country. **Which do you prefer?** And it is SO easy to become an operator. You do not necessarily require a teacher, nor do you have to go to a school to learn. 30 days of intelligent study will make you proficient. **Can you qualify** NOW? **Are you proficient?** Can you send and receive when your country calls you?

$1.35

THE "ELECTRO" CODOPHONE
(Patents Pending)

which we present herewith is the outcome of several months of intense study and experimentation of our Mr. H. Gernsback. It supersedes our former Radiotone Codegraph, which comprised a **Radiotone silent Buzzer, a loud talking telephone receiver** and **a key.** As in all of his work Mr. Gernsback strives for simplicity. So he combined the three above mentioned instruments with one stroke into **ONE** single instrument. He combined the Radiotone Buzzer and the loud talking receiver into a single unit, not only mechanically, **but electrically as well.** This involves **an entirely new principle,** never before attempted, and on which basic patents are now pending.

What this remarkable instrument is and does.

The "Electro" **Codophone** is positively the only instrument made that will imitate a 500 cycle note exactly as heard in a Wireless receiver, so closely and so wonderfully clear, that Radio operators gasp in astonishment when they first hear it. And you need no receivers over the ears to hear the imitation singing spark, which sounds for all the world like a high-pitched distant powerful Radio Station. No, the loud-talking receiver equipped with a horn, talks so loud that **you can hear the sound all over the room,** even if there is a lot of other noise.

THAT'S NOT ALL. By lessening or tightening the receiver cap, a tone from the lowest, softest quality, up to the loudest and highest screaming sound can be had in a few seconds.

FURTHERMORE, this jack-of-all-trades marvel, can be changed instantly into our famous silent Radiotone test buzzer, simply by replacing the metal diaphragm with a felt disc, **which we furnish with every instrument.**

FOR INTERCOMMUNICATION. Using two dry cells for each instrument, two **Codophones** when connected with one wire and return ground, can be used for intercommunication between two houses one-half mile apart. Any one station can call the other, no switches, no other appliances required. No call bell either, the loud-talking phone takes care of this.

AS AN ARMY TYPE BUZZER. Last, but not least, **two Codophones** with two 75 ohm receivers can be used to converse **over miles** of fine (No. 36 B & S Wire), so fine that no one can see the wire. Or you can use a long metallic fence and the ground, or you can communicate **over your 110 volt line up to several miles, using no wires, only the ground.**

Full directions how to do all this furnished with each instrument.

One outfit alone replaces the old-fashioned learner's telegraph set, consisting of key and sounder, which is all right to learn the telegraph code but not the wireless codes.

The "Electro" **Codophone** is a handsome, well made instrument, fool proof, and built for hard work. Contacts are of hard silver ⅛ inch in diameter, that will outlast the instrument. Housing is of metal throughout, horn and key lever nickel plated and buffed. Three new style metal binding posts are furnished.

There is also a neat code chart and full directions **enabling any intelligent young man or girl to learn the codes within 30 days,** practising one-half hour a day.

Sizes: 6¾ x 3 x 2⅝". Shipping weight, 4 lbs. **$1.35**

The "Electro" Codophone as described, complete

Money refunded if instrument is not as represented or does not come up fully to expectation.

There will be an enormous demand for this new marvel—place your order now. All orders filled in rotation. Better order two instruments today.

The "Electro" Radiotone

HIGH FREQUENCY SILENT TEST BUZZER

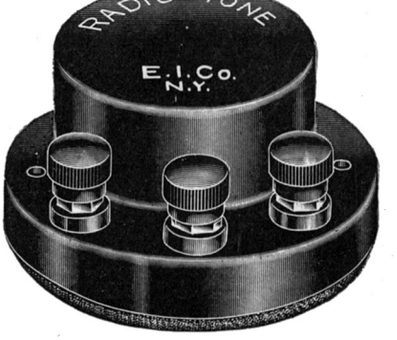
The RADIOTONE is NOT a mere test buzzer, it is infinitely more. Mr. H. Gernsback who designed this instrument labored incessantly to produce an instrument which would imitate the sound of a high power Wireless station as heard in a set of phones. This actually has been achieved in the RADIOTONE. This instrument gives a wonderful high pitched MUSICAL NOTE in the receivers, impossible to obtain with the ordinary test buzzer. The RADIOTONE is built along entirely new lines; it is NOT an ordinary buzzer, reconstructed in some manner. The RADIOTONE has a single fine steel reed vibrating at a remarkably high speed, adjusted to its most efficient frequency at the factory. Hard silver contacts are used to make the instrument last practically forever.

Yes, the RADIOTONE is **SILENT.** In fact, it is so silent that you must place your ear on top of it to hear its beautiful musical note.

You will be astounded at the wonderfully clear, 500 cycle note, sounding sharply in your receivers, when operated on one dry cell. **To learn the codes, there is absolutely nothing like it.** With the radiotone, a key and one dry cell and ANY telephone, a fine learner's set is had. Two or more such sets in series will afford no end of pleasure for intercommunication work. Particularly now that we cannot use our Wireless sets, the **Radiotone** is already in wonderful demand. All the interesting things as described with our **CODOPHONE** (see our ad above), can be performed with the **Radiotone,** a key, a dry cell and a phone.

Radiotone as described.....each **$.90**

IMMEDIATE SHIPMENTS



No. HK 1800

LABORATORY OUTFIT!

$1.25

We have spent considerable time to combine just such a practical outfit and present it herewith to our friends.

The outfit is complete as per illustration and consists of:

1 **Stand,** made of well quartered oak, varnished three times, so as to be acid proof and grooved on top and bottom, so that it will not warp in getting wet. Size 5¾ inches high by 11½ inches long.

1 **Glass Spirit Lamp.** Size 3½ inches by 2 inches. Uses wood alcohol and is invaluable to the experimenter. Besides being used to heat test-tubes contents as per illustration, it can be used to bend glass rods and tubings, to solder wire, etc.

1 **Glass Filter Funnel.** This funnel is made of heavy glass that will not break easily. It fits accurately in the hole on top of the Filter stand and is provided with a thick rim on the outlet, so that a rubber hose can be attached to it, without slipping off.

1 **Glass Rod,** to be used in stirring and mixing.

10 **Test Tubes,** made from the best imported glass. A new feature of some of the test tubes is that they have a flat bottom and therefore can be placed on any table if desired, needing no special stand.

1 **Roll of Copper Clad Steel Wire.** This wire is to be used to make a number of useful articles as shown in the illustration, such as test-tube holders, tripods to support retorts, etc. We furnish a blue print with the outfit, showing how to make all these wire articles.

Now this whole outfit as described costs you only **$1.25**

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With its electrical and mechanical improvements, the Columbia Electric Grafonola 225 E is an instrument embodying the most perfect reproducing qualities and refinement and one that will be as well a harmonious part of the best appointed music rooms. The motor, a marvel of silence and smoothness, holds the tone absolutely *true*. Price $225.

The Electrical Experimenter

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Vol. V Whole No. 55 NOVEMBER, 1917 No. 7

SEEING WIRELESS SIGNALS.....Front Cover
From a painting by George Wall
TELEGRAPH AND TELEPHONE ON EUROPEAN BATTLE-FIELDS 437
ELECTRICITY BEING USED TO HASTEN CROPS..... 439
ARE CABLE MESSAGES SAFE?..... 440
LOCATING UNDERGROUND ORES BY ELECTRICITY..... 441
SEEING WIRELESS SIGNALS (Front Cover Article)..... 442
MICROPHONES IN TRENCH WARFARE.....By H. Gernsback 443
"MOVIES" SHOW WOMEN'S PLACE IN WAR..... 444
HOW BIG ELECTRIC MEN WORK.....By George Holmes 445
SOMETHING NEW IN MICROPHONES..... 446
HISTORIC ELECTRIC APPARATUS.....
By H. Winfield Secor, E.E. 448
THE MARVELS OF RADIO-ACTIVITY. PART III.....
By Jerome S. Marcus, B. SC. (Ch. E.) 450
177,000 C. P. MERCURY VAPOR LAMPS LIGHT "MOVIE" STUDIO 452
BUCKING THE "LODGE GOAT"—ELECTRICITY..... 453
THE CAUSE AND NATURE OF MAGNETIC CURRENTS.....
By F. F. Mace 454
WELDING WITH THE ELECTRIC ARC..... 456
ACTION AT A DISTANCE AS EXHIBITED IN SELENIUM CRYSTALS.....By Prof. F. C. Brown, Ph. D. 459
EXPERIMENTAL PHYSICS—LESSON 9.....
By John J. Furia, A.B., M.A. 460
RADIO LEAGUE OF AMERICA—NEWS FROM COMM. D. W. TODD, U.S.N., AND THE "RADIO ROLL OF HONOR"... 461
BEING A NAVAL WIRELESS MAN.....
By Howard S. Pyle, U.S.N. 463
DEVELOPMENT OF AIRCRAFT RADIO IN THE U. S. NAVY
By Benjamin F. Miessner, Expert Radio Aide, U.S.N. 465
CONSTRUCTION OF A LABORATORY VACUUM PUMP.....
By Raymond Francis Yates 467
AN AUTOMATIC STORAGE BATTERY CHARGER.....
By Lewis Scriven 468
CHEMICAL ACTION OF STORAGE BATTERIES (Conclusion)
By Albert W. Wilsdon 473
HOW-TO-MAKE-IT DEPT.—Prize Contest..... 474
WRINKLES, RECIPES AND FORMULAS.....
Edited by S. Gernsback 476
EXPERIMENTAL CHEMISTRY—18th Lesson.....
By Albert W. Wilsdon 477
"ELECTRICAL LABORATORY"—Prize Contest..... 478
AN EXCEPTIONAL EXPERIMENTAL LABORATORY.....
By George Holmes and Albert W. Wilsdon 479
QUESTION BOX..... 482

Imagination Versus Facts

AS is well known, the ELECTRICAL EXPERIMENTER ever since its inception has been heavily indebted to Dame Imagination. Imagination makes the world go round—imagination means progress.

Sometimes we have been lauded for exploiting imagination, more often we have been criticised severely. Harsh things have not infrequently been said about our wholly imaginary writings and essays, and we will probably be thus criticised indefinitely.

We certainly lay no claim to the fact that our imaginary writings always turn out to be correct in the end, but we point with pardonable pride to the fact, that often our supposedly "pipe dreams" come true. Here is a recent, as well as concrete example:

In the early summer of 1915 while the German owners of the Sayville Wireless Station were still operating the latter unmolested, it occurred to us that "all was not well" with that particular station. Certain prominent amateurs mentioned the fact that "irregular" messages were being sent over Sayville. Then early in July 1915 our Government took over the Sayville Radio Station, but the German owners still remained on the grounds.

This partly prompted our editorial entitled *"Sayville"* in our August 1915 issue, in which we desired to convey the idea that even with our Government officials in charge, unneutral messages could still be sent out over Sayville.

This editorial at once brought a violent letter of protest from Dr. K. G. Frank, the then executive head of the Sayville Radio Station. Dr. Frank strenuously denied that Sayville was sending out unneutral messages, and closed his letter by strongly abusing this journal. In our reply (see our October 1915 issue for entire correspondence) we firmly voiced our former opinion that Sayville was indeed sending out such unneutral messages, and we then cited facts. Before proceeding we might mention that Dr. Frank has since been interned by this Government for the duration of the war.

But that unneutral messages actually were being sent out as late as 1916 and perhaps later came as a surprise even to us. Remember our own Government operators were in charge, but the wily Germans did just what we suspected them of having been doing right straight along.

We give below in one column an extract from our August 1915 editorial—an admittedly wholly imaginary case;—in the other column are shown the actual facts as recently disclosed by our State Department. This latter radio message was sent in April 1916 over Sayville, and was in connection with the famous Roger Casement affair. That the imaginary as well as the real message should both be addrest to bankers is rather startling, to say the least.

EXTRACT FROM OUR EDITORIAL, AUGUST 1915.

"Let us imagine the following: A German spy is located on the ocean liner *Adriatic* headed for Liverpool. When two days out the spy learns that the ship, on account of submarine danger, will not dock at Liverpool but at Greenock (Scotland) instead. He then sends a wireless to a stockbroker in New York as follows:

H. P. Frye & Co.,
Wall Street, New York.
Sell at once 2,000 shares U. S. Steel at 58.
John Miller.

When Frye & Co. receive the message they consult their code book and find that it reads thus:

"Adriatic will dock at Greenock."

Frye & Co., then sends this Radio via Sayville:

F. S. Schneider & Co.,
Friedrichstrasse, Berlin.
"Cannot dispose 2,000 shares shares U. S. Steel at 58.
Are bid 55½. Advise."
Frye & Co.

The message is promptly received by the German commander of submarine U-69 not far from the south coast of Ireland.

He reads the harmless message thus:

"Adriatic will dock at Greenock next Tuesday."

With this intelligence the German submarine commander is enabled to change his course in order to successfully hunt his quarry.

This is only one of the ways how the wireless stations at Sayville and Tuckerton can be used successfully to violate our neutrality; there are undoubtedly scores more."

DISCLOSURE BY OUR STATE DEPARTMENT, SEPTEMBER 1917.

"Along the same line is a code message by wireless to Banker Max Moebius, Oberwallstrasse, Berlin, which is interesting chiefly as showing the code method of important communications practised by the German Official plotters in this country. The code translation was found with the copy of the message among von Igel's papers. The original is a German dispatch which being translated into English, sounds like an innocent business transaction viz.:

National Germania Insurance Contract certainly promised. Executor is evidently satisfied with proposition. Necessary steps have been taken.
Henry Neuman.

Not so innocent and harmless as it looks, for what the message really means is this:

"Irish agree to proposition. The necessary steps have been taken."

Truth, indeed, is stranger than fiction, and imagination is often improved upon.

H. GERNSBACK.

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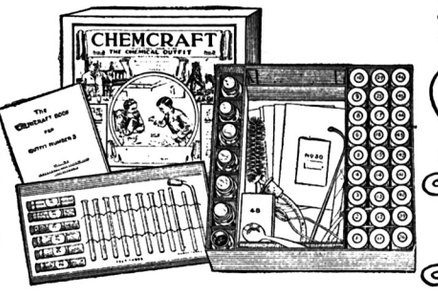

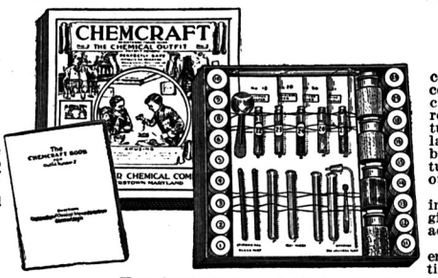

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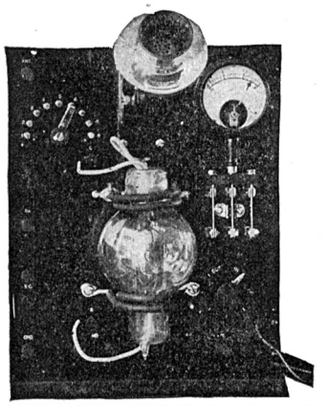

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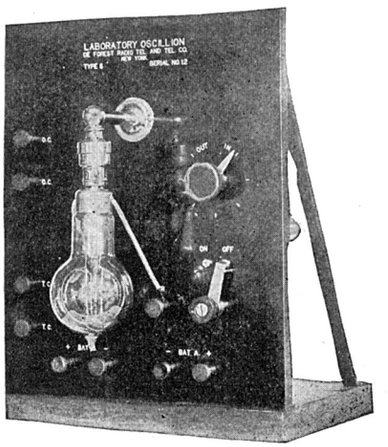
Oscillion Telegraph, capable of transmitting the voice 15 miles, or telegraphic messages 40 miles. Larger transmitters for greater ranges.



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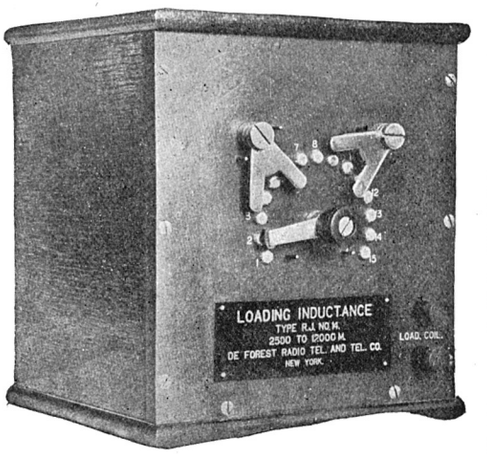
Generator of absolutely undamped oscillations of any frequency. Permits Radio Telephone speech surpassing in clearness that over any wire. For Laboratory and Research Work has a field utterly unfilled. Patents issued and pending.



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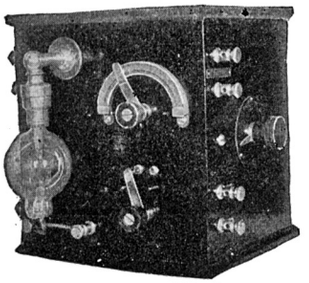
THE DE FOREST LOADING INDUCTANCE



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It is not a detector in any form.

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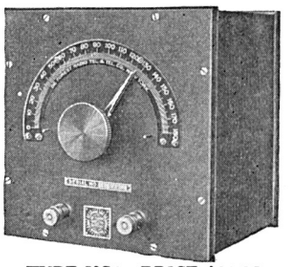
Cable Address: RADIOTEL, N. Y.



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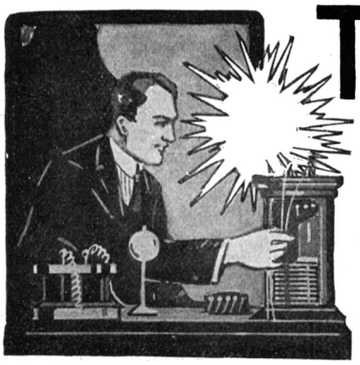
This Condenser is similar to our commercial type but is enclosed in an oak cabinet. It has 35 semi-circular aluminum plates. The maximum capacity is approximately .0025 M. F.



THE ELECTRICAL EXPERIMENTER

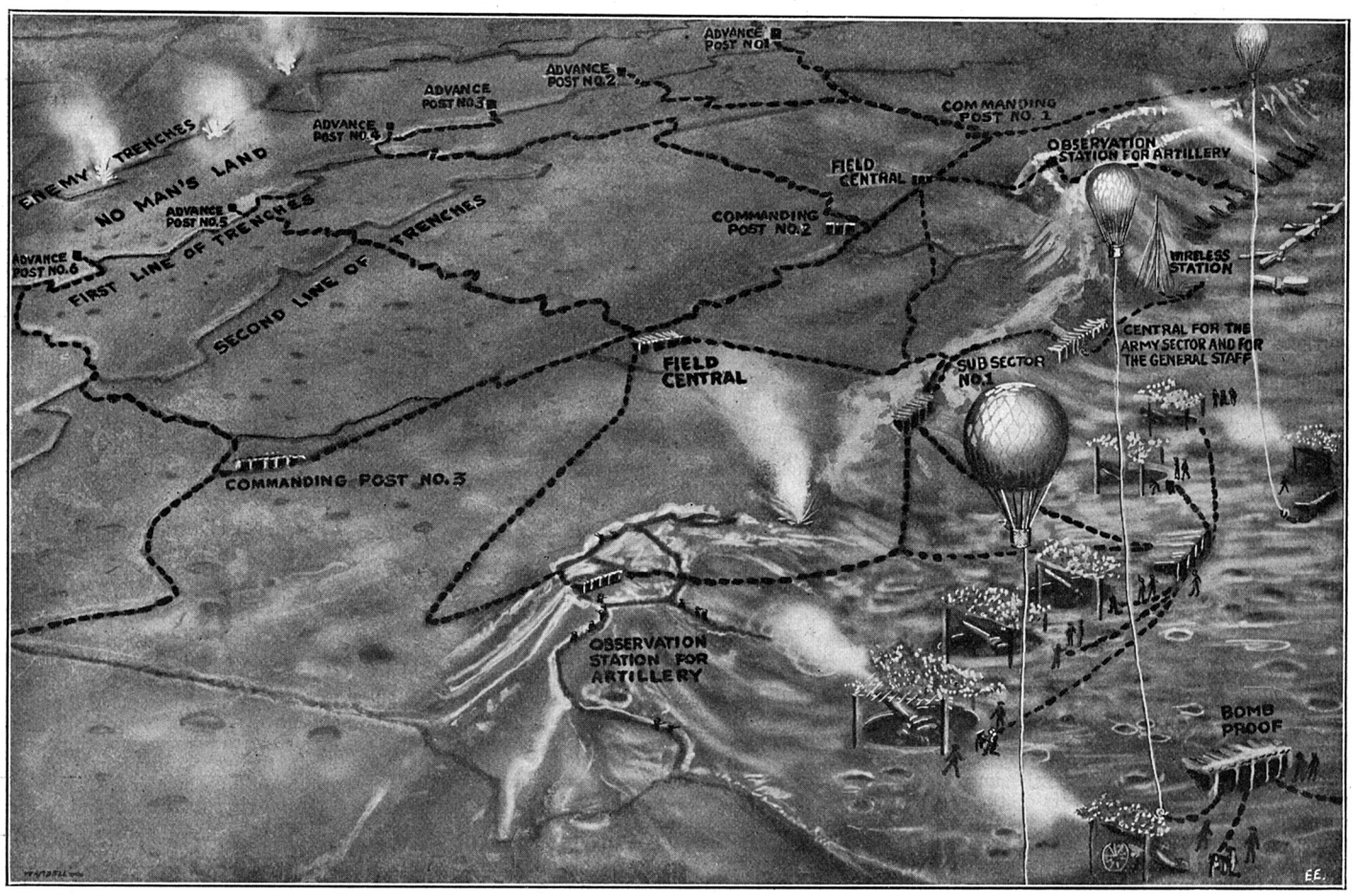
H. GERNSBACK EDITOR
H. W. SECOR ASSOCIATE EDITOR

Vol. V. Whole No. 55 November, 1917 Number 7

Telegraph and Telephone on European Battlefields

IN no war in the past have the electric signaling systems covered so many square miles or such a great diversity of requirements. The commanding general wants to know how a certain division is progressing; an artillery captain wants to ascertain just adventure, action—all of these come to the Signal Corps man in the pursuit of his duties more than ever before. To-day he may install a telephone switchboard in a cheerful little town near grand headquarters, situated a dozen miles back of the battle-front. To-morrow he may be came along and was pleased to learn that all of the circuits had been tested out without losing a man. The same captain was grieved to hear the next day that this brave lineman, his work done, had been picked out of a pole-top by a stray shell.

At the beginning of the war there were



A Birdseye View of a Modern Battle-field With the Various Telegraph and Telephone Lines Linking the Advanced Trenches With the Artillery in the Rear, Also Enabling the Post Commanders to Communicate at Once With Any Section of Trench Line for Combined Assaults. Note the Large Number of Shell Craters, Reproduced from Actual Photograph.

where his shells are dropping; these and a million other facts must be transmitted every hour of the day along the hundreds of miles of battle-front. And it is really marvelous how the army signal corps have perfected their frail looking wires and instruments, so that they will work under the most unfavorable conditions. Romance, stringing wires thru a shell-swept forest. One case which is on record will serve to show the lottery-like chance these men take. An English military lineman had been busy for several weeks in a district near the Aisne battle-front. He had about completed straightening out a perfect jungle of wires and circuits. His captain certain dangers connected with telephonic communication, for our foes were not slow to try to catch our communications, and their engineers were soon busily engaged establishing delicate microphones near our telephone lines, so as to intercept messages and learn of our projected actions, says Isidore Recoulier, commander of a section

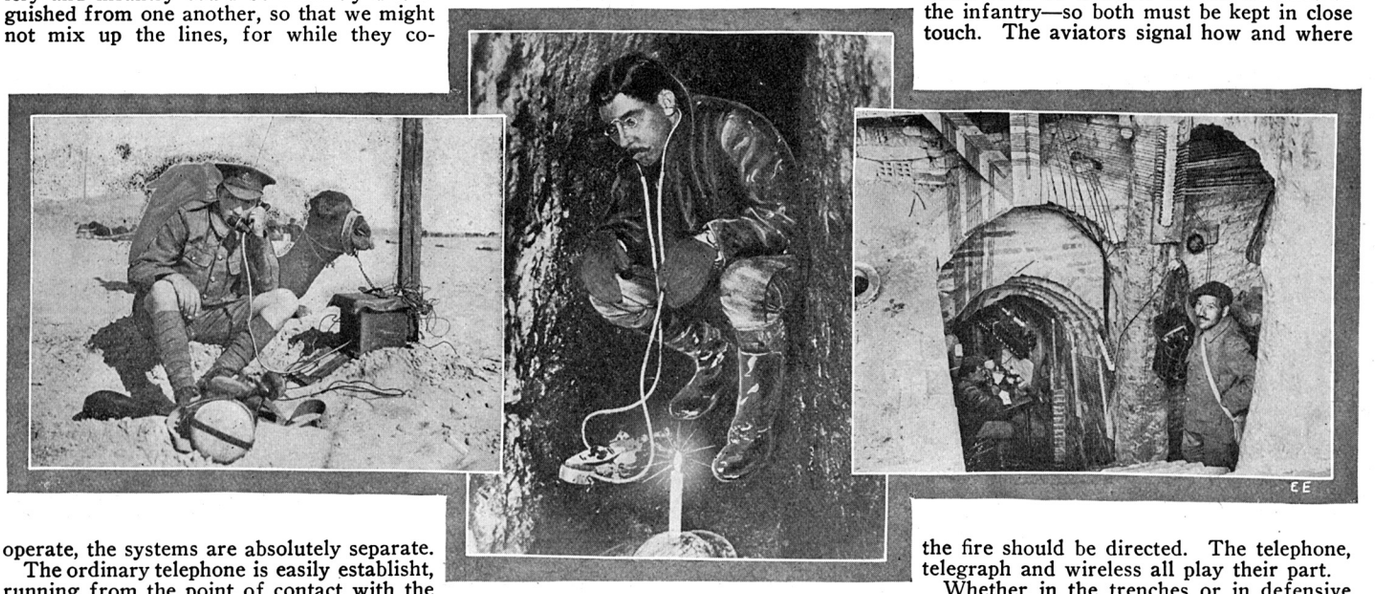
of French sapper telegraphers. We soon learned of this and have now apparatus by which any such "cutins" or listening is practically impossible, for great advances have been made in the arts of telephony since the beginning of the war.

We have had to develop a system by which the telephone wires used by the artillery and infantry could be instantly distinguished from one another, so that we might not mix up the lines, for while they co-operate, the systems are absolutely separate.

The ordinary telephone is easily establisht, running from the point of contact with the enemy to the chief of that sector, and from the sector itself to the commander. When these wires were so simply laid as at first it was easy for the enemy to "listen in," but now the current is returned by special conductors, and the use of spy microphones is almost impossible. The artillery has its telephone system, independent of the other lines, but connecting with the headquarters of attacking and defensive troops. A line is run on the front, in any way that the ground will permit, and kept in order at any risk. Often when the bombardment is heaviest, one of these wires is broken and must be repaired, while shot and shell burst among the engineers. When an attack is in progress the telephone engineers follow the line closely, installing new stations at the first possible moment, so as to keep in touch with the rear and the centre of command. If driven back, this corps has to pick up all material so that it will not fall into the hands of the enemy.

After the cannon, whose fire has been directed by aviators and captive balloons via radio, have smashed the trenches of the enemy, and they extend their fire, the infantry attack begins and, bayonets couched, the men advance. The various units follow each other in obedience to orders from their leaders. These orders are long since decided upon, and in the midst of this tumult all is directed by a general plan. Meanwhile, further to the rear, the generalissimo, the general commanders, the chiefs of the army corps, of divisions and brigades, with detail maps spread out before them, follow the movements and give their orders. All of this has to be done along the wires of the telephone.

The generalissimo is stationed in a house where many lines meet, so that he can be in constant communication with all the rear and the advance. Every chief of service in turn, as well as every commander of a unit, of one or more lines, is ready with a report, awaiting orders. The development of the telephonic communication between headquarters and all parts of the forces has been so perfected that it works without delay. Each army is connected with General Headquarters by a line at the end of which an officer receives all useful information, making it possible for him to follow the least movement of his troops. Near this officer another insures his connection with the aides of the generalissimo, especially charged with conveying orders from the chief of the army. These orders are called "Directives."



Photos from Central News Photo Service

Left.—A Photo From the Egyptian Battle-Front. Advanced English Artilleryman Telephoning Warning of Enemy Aircraft Approaching. Note the Camel.

Center.—A French Officer of Engineers in a Mine Gallery, with Newly Invented Microphone, Detecting the Sounds of German Counter Mining Operations. Men Who Do This Work Are Called "Listeners." Listening Is a Very Delicate Operation. It Consists of Detecting the Direction, Height, and Distance of the Sounds Heard. To Obtain Greater Clearness, Drums Are Used as Well as Special Microphones. As Soon as a Prolonged Silence on the Part of the Enemy Is Noticed After a Period of Rather Hard Work, the Conclusion Is That a Chamber Is Being Loaded, and at Once You Charge Your Own Mine. The Loading of the Mine-Chamber Is Followed by the Operations of Connecting the Fuse and Tamping. The Latter Consists of Blocking Up the Mine-Chamber with Bags of Earth or Sand, so as to Direct the Force of the Explosion Towards the Enemy.

Right.—A Central Telephone Station in the French Trenches at the Aisne.

In its turn the general quarters of an army is connected with general headquarters from which it receives orders and to which reports of each phase of action must speed. Moreover, it is in close communication with neighboring armies as well as with the army corps under its direction.

Each army corps is itself connected with the army of which it is a part, and as follows: From the army corps to division, to the brigade, to regiments, to the trenches as far as the first line and outposts.

This primary circuit allows the sending of orders and knowledge as to how they are carried out.

The telephonic circuits of the artillery are much more complicated. It plays the same part as the former for batteries and groups; but more than this, it serves for reporting on location of objectives and directing the fire. It has to insure the co-operation of the various groups of artillery with one another, and the connection of these groups with the wireless headquarters, which are in direct connection with observers on aeroplanes and captive balloons, as well as with posts of observation on the ground.

It must not be forgotten that the artillery works by concentration of fire. The artillery must prepare the way by battering down forts or trenches for the advance of the infantry—so both must be kept in close touch. The aviators signal how and where the fire should be directed. The telephone, telegraph and wireless all play their part.

Whether in the trenches or in defensive operations the telephone has a great immediate value, and even in advance movements, whenever a halt takes place the very first duty of the engineering corps (telegraphic division), is to establish communication by telephone with the rear. The military telephone is quite different from the regular machine. It consists in its simplest form of a "combination" (microphone and telephonic ear-piece, joined by a hard rubber handle, etc), the branch-box, induction coil box and battery for producing the current. In setting the wires care is taken to prevent "grounding," isolating the wires as carefully as possible. Usually the line is laid by four men; an unroller (of the wire), an assistant, a mounter and assistant. The unroller carries the wire on a bobbin in his left hand, playing the wire out slowly. His assistant keeps the wire straight. The mounter attaches the wire to the point of departure, his assistant hands him the wire as needed, who lays it upon its supports as he advances. When he reaches the end of a piece of cable he tests his connection carefully to the point of departure. He marks by a pebble or bit of paper the point where he has connected each 500 yard cable, in case of breaks. He locates his stations in the safest possible places, out of view of the enemy, or protected as much as possible. If an advanced position must be abandoned, the corps in charge of the laying work takes up the wires as rapidly as possible, removing all memoranda from the station, and beat a retreat with the line.

Wireless has proved of great value for aviators to convey their information to their forces, and only within the last year and a half has the method of communication been perfected. For obvious reasons the construction of the antennae and other parts cannot be described. Suffice it to say that methods of communication between the aeroplanes and the ground have been devised, and they are of such kind that the enemy cannot intercept the messages. The captive balloons use a telephone wire which unrolls as the balloon ascends. Batteries alone are possible in campaign telephony, and special batteries have been devised which are both light and powerful.

Electricity Being Used to Hasten Crops

EXPERIMENTS on a large scale with the use of electricity to stimulate the growing of crops are among the English government's latest efforts to increase the country's home food production. The department of agriculture has taken over a large area near Hereford, where installations have already been set up for the use of ionized agricultural experts under Prof. W. H. Blackman of the Imperial College of Science and Technology who will supervise the experiments.

In the Hereford experiment high tension alternating current is to be used. Spring wheat, barley, oats and clover will be dealt with, and fertilizers of various types will also be used in these experiments.

The method adopted is to stretch over the field to be treated a number of thin wires on poles, something like low telegraph wires, but high enough for loaded wagons to pass underneath. The wires are supported by high tension insulators on posts in long parallel spans thirty feet apart.

"The charge fizzes off from the wires," says one account, "with a sound which is sometimes audible, and with a glow which is visible in the dark. Anyone walking about below the wires can sometimes feel the effect on the hair of the head, as a cobweb on the face. The electricity does not act as a fertilizer but as a substitute for sunlight. The current is only used in the early morning and in cloudy weather." The initial cost of the apparatus for twenty-four acres is about $1,500, and the animal cost, including depreciation and labor, is about $300, which is not so very high.

The present method of overhead discharge from wires stretched over the crops was introduced into England twenty years ago by Professor Lemstrom of Helsingfors, whose book, "Electricity in Agriculture and Horticulture," anyone interested in the subject should consult. The method was modified by Mr. J. E. Newman, in conjunction with Sir Oliver Lodge. These and others formed themselves into the Agricultural Electric Discharge Company, which disposed of a large number of installations both in England and abroad.

Very contradictory results were obtained by the various users of the Lodge-Newman apparatus, and the subject lost much prestige. The results of the company's own experiments with wheat in over a series of years were reported as an increase varying from 0 per cent to 39 per cent. The next phase in the development of electroculture opened in 1911. The British Board of Agriculture gave a grant to Professor Priestley of Leeds for a scientific investigation of these new methods and their value. Professor Priestley collaborated with Mr. I. Jorgensen, an electrical expert and plant physiologist, and with Miss E. C. Dudgeon of Dumfries. In the result it appeared that many technical difficulties existed. At first no favorable results were obtained, but in the last two years, with improved methods, increases of 50 per cent over the ordinary crop have been recorded with oats on Miss Dudgeon's land.

A very complete installation has recently been connected up in the extensive vegetable gardens owned by Sir Thomas E. Roberts, near Carnarvon in Wales.

The engineers of the Carnarvon plant are convinced of several important features which have not been previously noted. They are emphatically of opinion that the ionization of atmosphere is but of secondary importance, though attention is being particularly paid to the influence of prevailing winds to widen the area of influence. They maintain the main effect of the discharge is noticeable on the soil, and that soils heavily manured are more effectively benefited by reason of the latent humidity. The active result upon the soil is apparently due to the release and nitrification essential to the well-being of plant life.

The dark green foliage and the building-up of new tissue is evident proof of the greater vigor and increased growth of the plant. Furthermore, confirmation is provided of the fact that sunlight is detrimental for the discharge to be in operation at the same time (more successful working is obtained at sunrise and sunset); a time-switch can be automatically arranged to switch the current on and off at these times.

This fact also emphasizes the approximate degree of humidity necessary for the success of the discharge, as the amount of dew or latent humidity prevalent at these periods are more or less helpful. Whereas, in heavy rain the discharge is inclined to run to waste, owing to insulation troubles. It must be borne in mind that the intensified and rectified voltage of 75,000 volts to 100,000 volts has to be dealt with in a very different manner to the ordinary electric light voltage, and the methods of control

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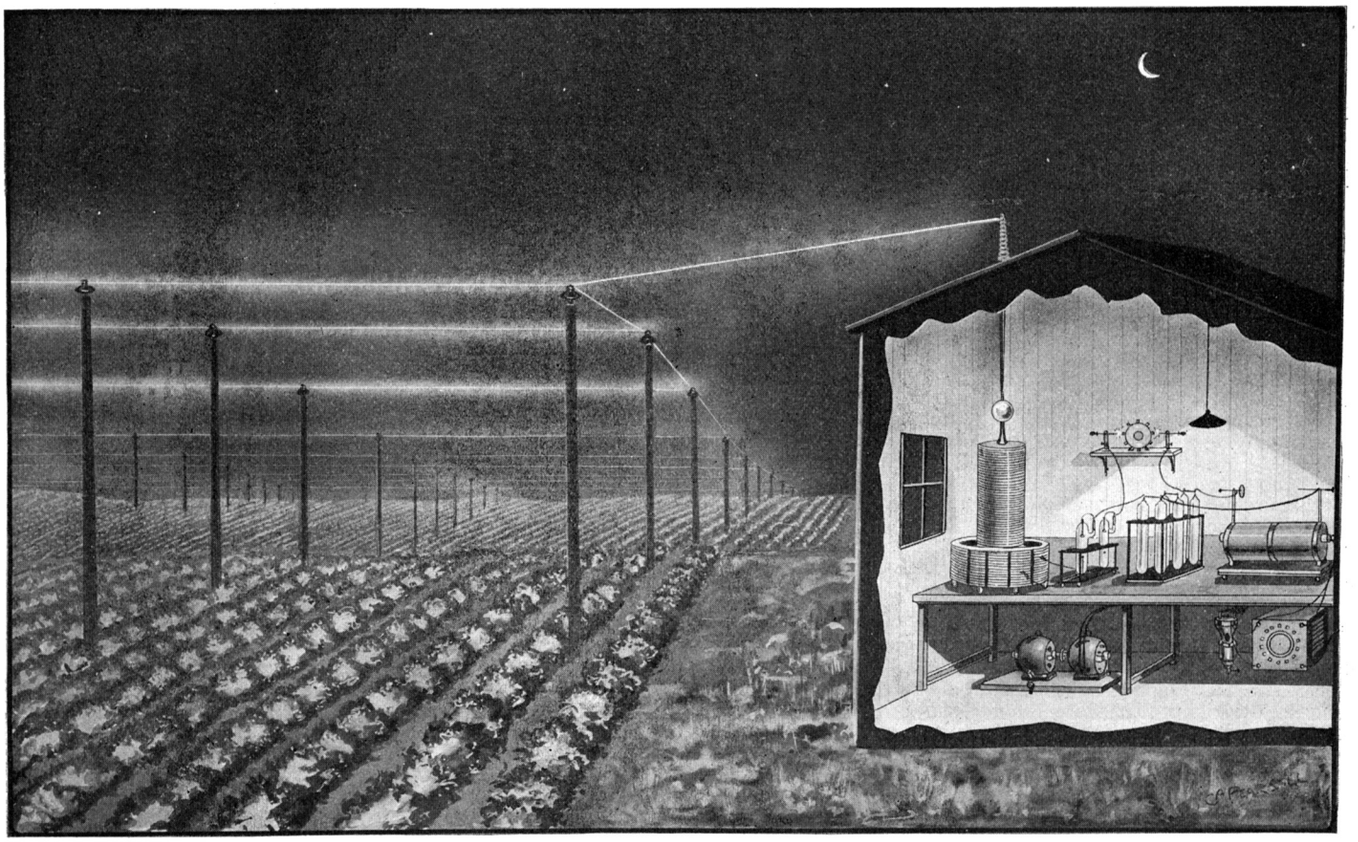


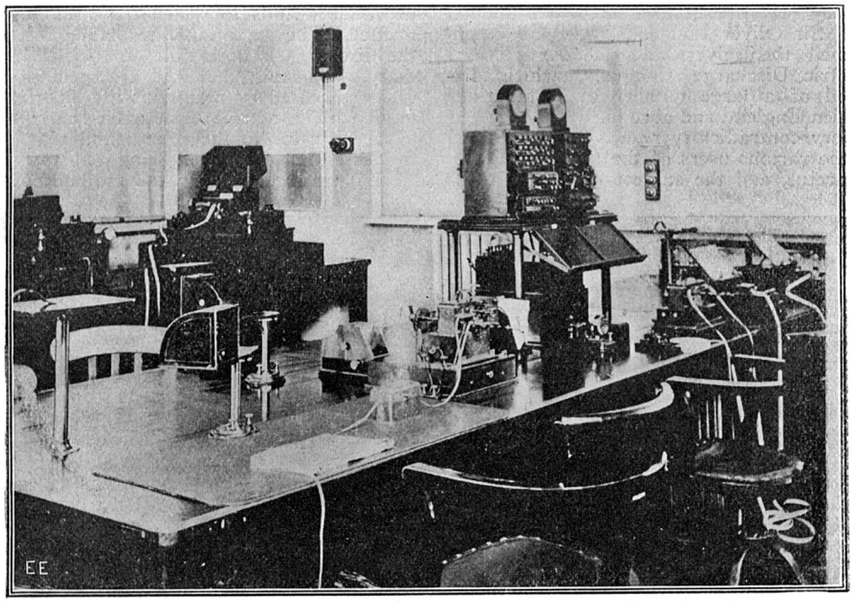
NIGHT-SCENE OF AN ENGLISH HIGH FREQUENCY PLANT GROWER.

In England, More Than in the United States, the Stimulating Effect of a High Tension, High Frequency Discharge on the Growth of Plants, Particularly Vegetables, Is Being Carefully and Extensively Tested Out. Standard High Voltage Electric Generators for This Purpose Are Available on the English Market.

Are Cable Messages Safe?

THE great activity of the Kaiser's sub-sea fighters have led many people to ask the question—"what of our ocean cables?" One of the leading cable experts in this country recently answered this question by saying—"Well, let the Huns cut the cables; what of it? In 48 hours the cable companies would have a fleet of repair boats on the spot splicing the cables, suitably convoyed by naval vessels and this would hold good for either European or American coasts."

People in general are quite unfamiliar with the ocean cable and its maintenance, especially during war times. At present, and in fact since the United States declared war against Germany, the cable companies have taken proper steps to have all land lines closely guarded night and day. A fleet of cable repair ships carrying expert repairmen and engineers are always waiting to dart here and there, as soon as they receive the news that a cable has gone bad or been cut. If the cable ship has only to make repairs along the shore or a short distance out, no naval convoy is required. However, if the cable ship has to proceed to sea, then a naval escort is furnished as a hostile submarine would be an unwelcome visitor, besides causing the cable ship to drop the cable ends, which it possibly had picked up after a long hunt, in its effort to out-run the U-boat. Altho not public knowledge, one of the leading cable companies has lost one of its best cable repair and supply ships, it having been torpedoed in the Mediterranean. The crew was saved, luckily, as the ship was not far from shore.



Photos from Donald McNicol

Fig. 1. What the Interior of a Modern Ocean Cable Office Looks Like. This is the Trans-Atlantic Cable Office at Penzance, England, the No. 1 London Wire, Duplexed, and Creed Automatic Cable Instruments Being Shown.

The accompanying picture, Fig. 1, shows an interior view of the Trans-Atlantic cable station at Penzance, England. The apparatus on one of the circuits extending to London, England, is shown on the table, to the right. The wire is *duplexed*, (*i.e.*, two different messages are sent over the cable at the same time), and is operated in the same manner as the longer Trans-Atlantic sections. In the back-ground is shown a set of "Creed" automatic cable instruments.

The second picture, Fig. 2, shows one corner of the operating room of the Trans-Atlantic cable office at Penzance, England. The two instruments on the right are "Creed" automatic transmitters. As the perforated paper tape passes thru the transmitters, it falls into baskets as shown. Just to the left of the second instrument from the left of the picture, may be seen one of the double-lever hand keys used by cable operators.

The maintenance of ocean cables is one of the most interesting studies. A peculiar fact in this direction is that of the 18 Trans-Atlantic cables now in service there are always two out of order; not the same two of course, but two out of the total number. Thus the cable ships always find something to do, in both winter and summer.

There are now 18 ocean cables linking America with Europe. The cable terminals are practically all under military guard and even the officers of the cable companies are not allowed near the cable land lines or terminal buildings, unless on special business and then only when accompanied by a military guard.

OBSERVATIONS OF ATMOSPHERIC ELECTRICITY AND OCEAN MAGNETIC WORK.

A series of volumes reprinted from the publications of the Carnegie Institute, Washington (U.S.A.), describe in detail the work undertaken by the "Galilee" (1907-8) and the "Carnegie" (1909-1916) in connection with electric and magnetic observations at sea. The three volumes before us deal respectively with ocean magnetic work and atmospheric electric observations, records of which are presented in a very complete and elaborate way. The accurate determination of the intensity of the earth's magnetic field at sea naturally offers special difficulties, such as do not occur in a well-equipt laboratory on land, and magnetic storms can also be reckoned with, altho their effect seems to have been relatively small and transient. In the earlier researches on the "Galilee" the observer had also to contend with the difficulty of a magnetic ship. The design and mounting of the various instruments are described in great detail, and this collection of data presented will no doubt constitute a valuable record.

SUBMARINES SEE WITHOUT PERISCOPES?

The *Revista Maritima* mentions that submarines are now being constructed without periscopes of the ordinary type. Instead of the usual vertical tube arrangement a system of two lenses, one on either side of the vessel, is being employed. It is claimed that this device is much less visible from a distance, altho it has the drawback that the vessel must navigate nearer to the surface. The device appears to be only in the experimental stage.

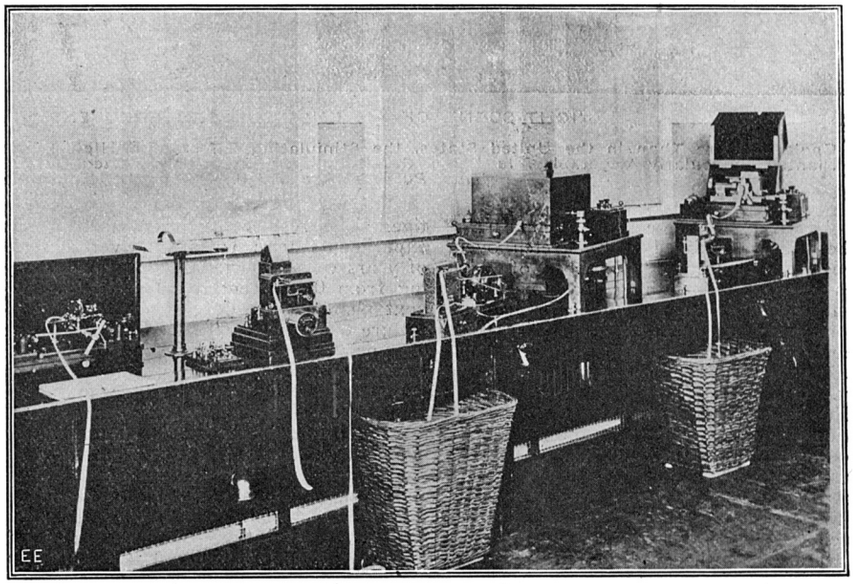


Fig. 2. This Picture Shows One Corner of the Operating Room of the Trans-Atlantic Cable Office at Penzance, England. The Perforated Paper Tape Passes Thru the Automatic Transmitters Which Send Out the Dots and Dashes Thru the Cables.

Locating Underground Ores by Electricity

THE basic problem to the mining industry is the finding of ore in paying quantities. This difficulty has produced many operators of the divining rod, and several other methods have been tried in the effort to determine the hidden ore conditions underground and avoid the expense of drilling or of sinking shafts in barren grounds. The whole subject is of great interest, and the possibilities are so vast that no one need be surprised at the large number of divining-rod operators or their varied methods of working. I have known some remarkable facts about divining rods, but the final results in every case have had no probability of development to a condition of certainty that would warrant a business investment, and almost every operator of a divining rod is afflicted with an over-developed imagination.

In an effort to reach the desired result of being able to determine the position of an orebody under the surface of the ground, the idea of exploring the ground magnetically was conceived, and during the last three years has been developed, first by laboratory work to establish a suitable method, and later by field work to apply the laboratory method to actual working conditions, says H. R. Conklin in *Engineering and Mining Journal*. Patents are pending for this method, which will be of interest in many fields of prospecting work.

If a high-frequency oscillating electric current, such as is used in wireless telegraphy, be confined to a closed circular circuit, a high-frequency oscillating magnetic field is induced within this circuit, and the arrangement becomes a solenoid of practically no length and of large diameter. Any electrical conductor that may be included in this induced magnetic field will have an oscillating current induced within it, and this induced current in turn induces a high-frequency oscillating magnetic field, which reacts on the original magnetic field, reducing its intensity.

The necessary conditions are that the ore or ores sought for shall be conductors of electricity, for the method described enables the location of an electrical conductor, and the fact that certain ores are such conductors makes their location possible. An ore that is not electrically conductive cannot be determined by this method. Native meals, most sulfids and chlorids, but very few carbonats, silicats or oxids are such conductors.

The progress of laboratory experiments was slow and tedious, and the difficulty of adapting these experiments to field work and designing the necessary instruments was even greater. The final satisfactory results are shown by reference to Fig. 1, in which 1 is an alternating-current generator or other source of alternating current, supplying the low-tension coil 4 of a transformer, through a regulating, inductive resistance 5. The high-tension transformer coil 8 is connected to a suitable spark gap *s* in parallel with condensers 9 and 10 and the primary coil 11.

The primary coil 11 is laid in a circle on the surface of the ground, and within it is produced the oscillating magnetic field. This magnetic field decreases toward the center of the primary coil and might be plotted as shown in Fig. 2, in which the ordinates represent change in magnetic flux. Owing to unavoidable variations in the original source of power, these ordinates may vary during observations to an extent greater than their diminution due to the neighborhood of an electrical conductor, so that the measurement of this magnetic field requires a balanced method.

For measuring this magnetic field, two identical exploring coils 12 and 13 (Fig. 1), of suitable diameter and number of turns, are connected in series with two current rectifiers 16 and a sensitive galvanometer 17. By placing one of these exploring coils at a measured distance from the center of the primary coil and moving the other around the center, the induced currents in the exploring coils being opposed to each other, a line, along which the magnetic flux is equal, is established and may be plotted. The location of the movable exploring coil, when the galvanometer reading is a minimum, determines this line, which may be called an isogonic line and is similar to a contour line on a topographic map. In the latter comparison the completed plot of these lines suggests contour lines defining a depression, as shown in cross-section in Fig. 2. Now if the magnetic flux be decreased as at A in Fig. 2, due to the presence of a conductor of electricity, the contour lines are drawn out in the direction of the conductor, and the plotted curves are distorted from the normal circular form, enabling the location of the conductor to be determined.

Several sets of actual distorted contour lines, as determined in the field, are shown in Figs. 3 and 4. All were observed with the primary coil two hundred feet in diameter. One of these plots, in Fig. 4, shows the location of a 2-in. iron pipe line buried about a foot underground, and is also distorted by a body of conductor still deeper.

The primary coil is shifted and these contour lines plotted for a sufficient number of centers to determine the general size and dimensions of the body of conductor, after which prospect drilling is done to prove the depth, thickness and quality of the conducting orebody. If the conducting orebody be below and nearly symmetrical

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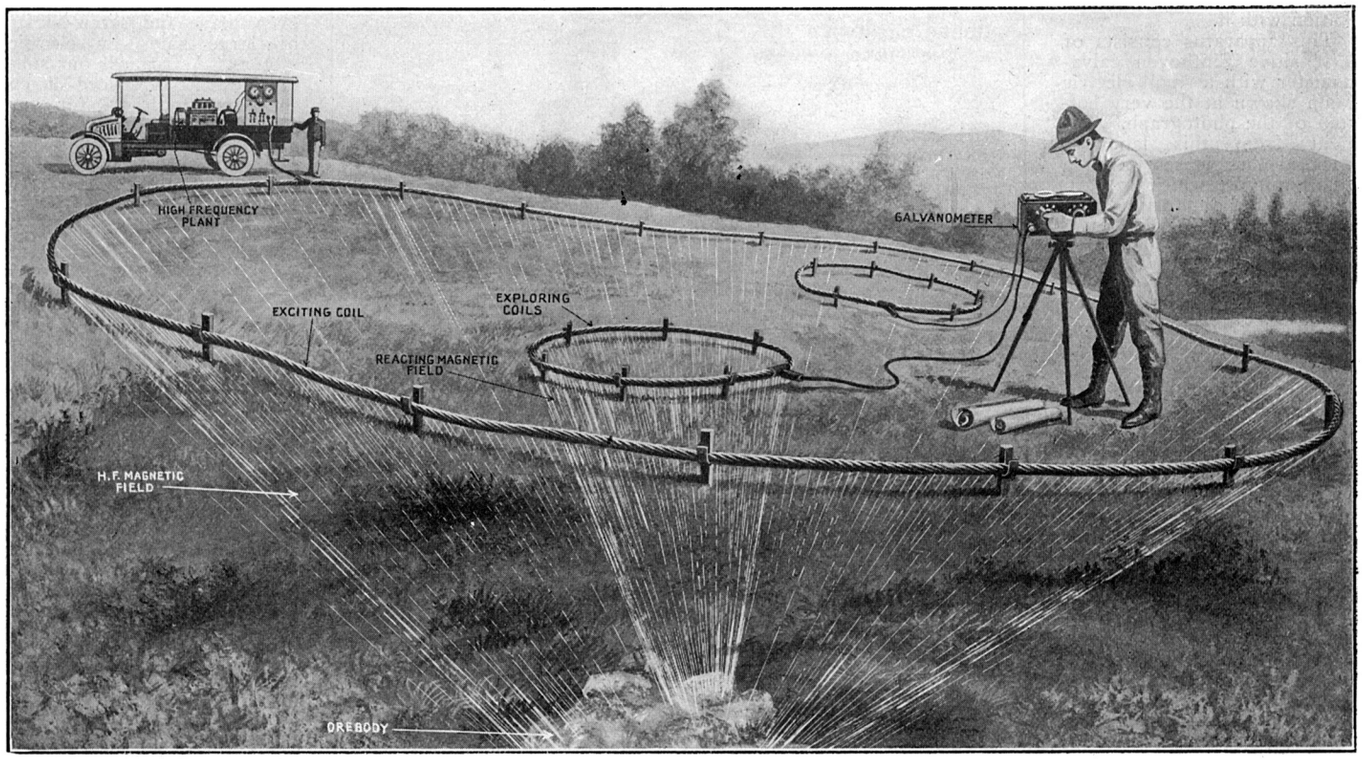


The Latest Feat in Mining Engineering Is the Exact Location of Underground Metallic Ores by Means of Induction. The Larger Coil Is Excited by a High Frequency Current from a Portable Dynamo Outfit. The Magnetic Field Created Affects the Ore Body, Which Reacts on the Smaller Exploring Coils and Indicating Instruments.

Seeing Wireless Signals

OUR front cover illustration shows one of the latest wireless signaling devices perfected by Teutonic experts. With this device the reception of radio messages on a flying aeroplane is made much more positive, inasmuch as the noise from the engine or machine gun does not interfere in the least with it, as is the case where the aerial radio operator has to listen in a pair of sensitive head telephones.

We are indebted to William Dubelier, a radio-engineer of New York City, for the description and photograph of this remarkable instrument, who personally saw this apparatus in the Berliner factory at Vienna, Austria, and besides had the pleasure of observing signals being received from a distant station with it.

This apparatus consists of a sensitive Einthoven galvanometer with a small electric lamp shown at the very bottom of the photograph. The light from this lamp is focused thru lenses on to a small mirror, which in turn reflects the light thru a magnifying glass, the same as in an opera glass. The upper part thru which the observer looks is constructed on the prismatic binocular principle, making the sighting apparatus equivalent to six times its length.

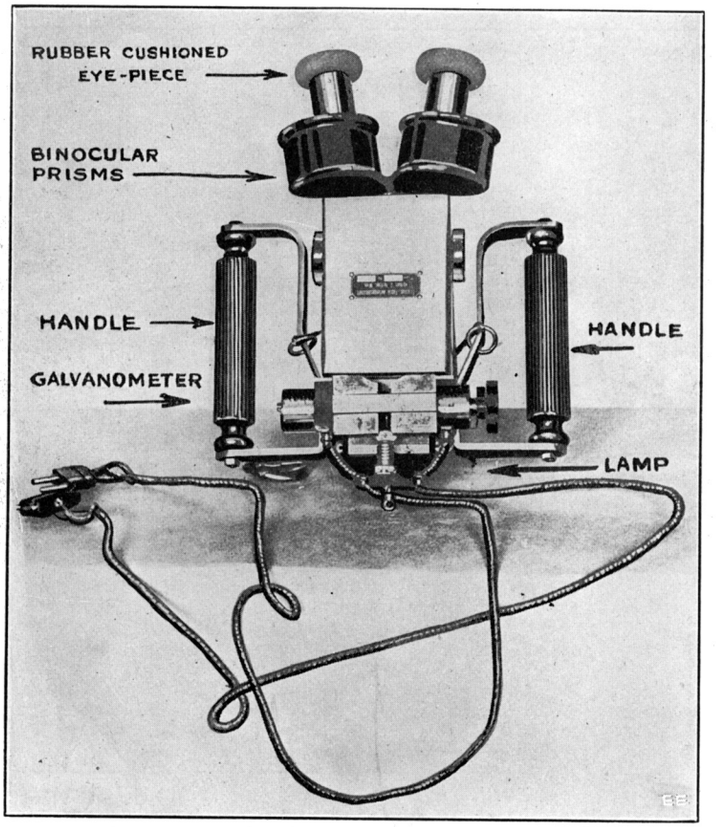
In other words, the observer does not actually see the wireless signal or wave literally speaking; he only sees the effect of the etheric wave, after it has impinged on the antenna attached to the aeroplane, and after it has past thru the tiny quartz fiber suspended between the poles of a strong magnet, and perpendicularly to the magnetic flux lines. If a weak current, such as a received radio signal current, passes thru this quartz fiber, the latter will be displaced from its normal position in a direction perpendicular to its axis and to the magnetic flux lines.

The fine galvanometer string moves in front of a narrow slot, illuminated by the small lamp fed from a battery (see illustration). An optical reproduction of the slit and wire is thrown on the sensitive retina and pupil of the eyes, one of the most sensitive devices we know of. As the messages come in, in the form of telegraphic dots and dashes—short and long signals—the quartz string is deflected back and forth correspondingly; thus the radio operator "sees" the incoming signals. A short deflection indicates a "dot," while a longer deflection represents a "dash."

The apparatus just described and here pictured serves the same function as the detector used in all radio receiving sets. It is usual therefore to connect it with some form of tuning coil or transformer, so that the outfit can be readily tuned to the proper wave length.

As the front cover illustration shows the operator holds the instrument with both hands, or only one hand, if he desires to write down the message received. This he can readily do with a little practise, keeping one eye on the instrument and the other on the message pad as he writes. A good operator can write down a message without looking at his pen or pencil. Besides, it is not impractical to install a light weight typewriter on the aeroplane; and "touch typists" never have to look at the keyboard. Radio and wire telegraphists are daily using the typewriter in just this way, by the thousand.

The principle of the optical and photographic reception of radio signals is not new. The efficacy of the Einthoven string galvanometer in this rôle was quite thoroly tested out by the Poulsen radio experts, both in this country and abroad. The American Poulsen interests—the Federal Telegraph Company of San Francisco—spent many thousands of dollars in their researches on this method of receiving radio signals, the only difference being that the movements of the quartz string were highly magnified and recorded photographically on a moving film. It is hopeful that this work may be taken up again and followed up to a successful conclusion. The United States needs the best it can get for every branch of its military service and it would seem that the apparatus here described and being successfully manufactured in Germany can certainly be duplicated, and no doubt considerably improved, in this nation of vast industrial and scientific resources.



Here Is the Latest Teutonic War Device. It Permits the Radio Operator in a Flying Machine to "See" the Wireless Signals. Thus the Engine and Other Noises Do Not Bother Him in the Least.

ELECTRICITY AND WAR IN LAND OF THE "HEINIES."

The "Frankfurter Zeitung" announces that the German Government has requisitioned all electrical machinery and apparatus, and it is not now possible to buy or sell electric motors without special permission.

In an article in the "Cologne Gazette" on a visit to Kiel, where the dockyards are said to be mainly, but not entirely, engaged with repairing work, contains the following passage on copper and electricity:

"Copper is now used in large quantities in all ships, altho, of course, consumption is restricted as much as possible. Especially for steam piping there is no substitute for copper, and it is also needed for all purposes where high resistance to sea water and salt air is necessary.

"Over against the boiler shop is the electrical shop, which becomes every day more important with the increased use of electricity. We have already gone a long way in this direction, altho we have not yet gone quite so far as the Americans, who even drive the screw-shafts of large ships by electric motors. As regards our submarines, it is indeed much the same with us, for our submarines already consist half of electricity. The submarines are also concerned with the accumulator shop, where accumulators are repaired. Repair is not always possible, for the demands made on the accumulators in war are sometimes too great."

BOOKS FOR OUR SOLDIERS.

While furnishing books, magazines and other literature to these men,whom we are beginning to consider truly "our own," we should not forget that there are large forces in France with quite as keen a desire for American literature and with far less chance of having it satisfied. An appeal has just been issued calling attention to this need.

In New York City books may be put in packages marked for the "American Overseas Force" and left with any public library. They should be in fairly good condition. Magazines are wanted —and contributors are requested not to send periodicals more than two years old.

The type of books our Sammies enjoy? Fiction first; then French grammars and dictionaries, first-year French books, volumes of travel, biography, history; books on aviation, wireless telegraphy, submarines, automobiles and mechanics.

Don't forget that there are men with the overseas forces who have been educated to a taste for the best of literature. "Sartor Resartus," or "God, the Invisible King," will be received as avidly as one of E. Philip Oppenheim's novels. There are men in the army with Harvard and Yale and Cornell educations—and with a corresponding literary appetite. And the army also includes men with little schooling. Consequently you have a broad and almost unlimited field for literary charity, and don't fail to read the notice on the front cover of this journal.

THE ELECTRIC TAXI.

For crowded traffic (ease of control), simplicity, ease of operating and freedom from engine troubles, the electric taxi is coming well into favor.

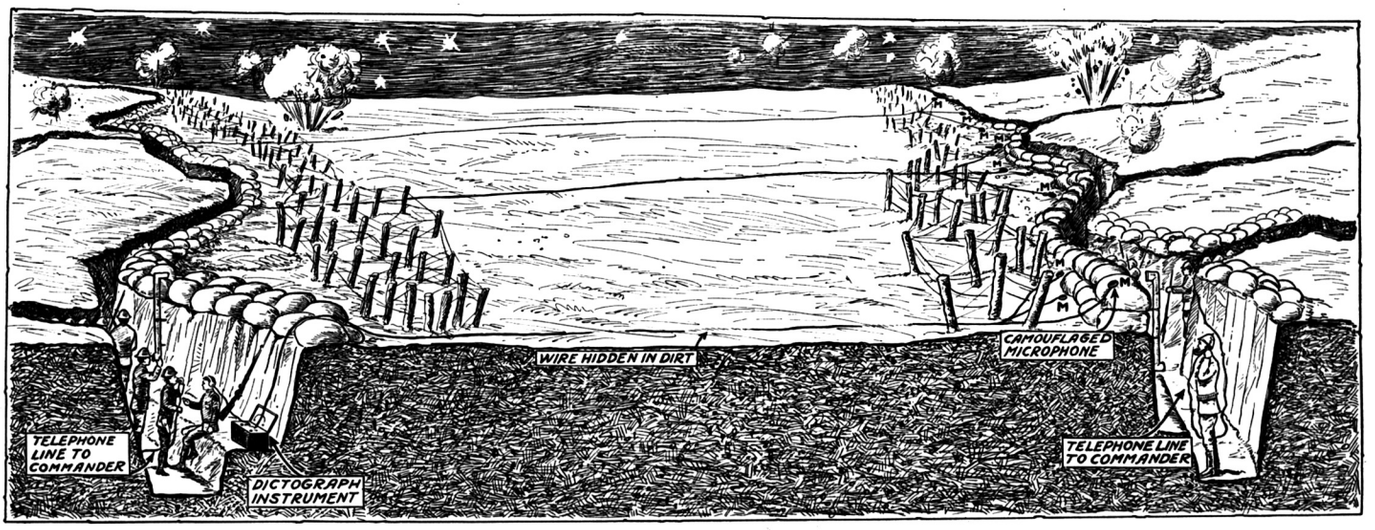
Microphones in Trench Warfare

By H. GERNSBACK

THERE is hardly a spot on earth today where modern science receives as many professional tryouts as in our war trenches. New methods, new schemes, new inventions are being tried out forever, and like many another game it settles down to a game of wits where that side having the most brains and the most ingenuity is likely to win out in the end.

be obtained by what is popularly called the *dictagraph*. But the question immediately comes up, how are the dictagraphs to be placed in the enemy's trenches? Of course, while it is rather a ticklish business, it is not impossible and our illustration shows how it could be readily accomplisht.

We first need our sensitive microphones will not be discovered. It should be remembered that grass or vegetation growing over the microphones as well as over the fine cable will practically conceal both entirely from view. The same is true of dust and sand, etc., which all aid in hiding the microphone. Naturally a microphone of this kind must be rugged and the arrangement should be such that no matter



Listening to the Doings In the Enemy's Trenches By Means of Supersensitive Microphones Is a Recent Idea. It Shows a New Way How to Get Advance Information, as, for Instance, Just When the Enemy Intends to Attack, Etc., Etc.

When two forces are deadlocked against each other and when it becomes practically impossible to pass over the intervening "No Man's Land" with assailing forces, it is of primary importance to know what is going on in the other fellow's trenches. It being impossible to raise the head above the parapet due to continuous bullet streams, the men in the trenches are more or less on edge continuously, as they do not know what is going to happen next. Consequently most of the reconnoitering is done during the night, and to counteract this the enemy uses the so-called *star-shells* which illuminate the landscape for miles around for a period of a few seconds. During this time there is always an opportunity to catch advancing forces or patrols and thus annihilate them.

The thing that a commander is most interested in, is to know just when the enemy is going to leave his trenches to make an attack. If he could know exactly at what time such an attack is to be made, this information would often be of priceless value. Of course, it goes without saying that the enemy is not likely to give away such information if he can help it. Advance posts in advanced trenches, called in field parlance "listening posts," are of course quite satisfactory, but they do not get advance information, and they are simply there to stop an advancing force or to tell the men behind the lines as soon as the attack has started. This listening post is usually a shell hole somewhere between the trenches in "No Man's Land" well fortified with sand bags, and well in advance of the front trenches. It is usually manned by two men, and a machine gun or sometimes rifles only. It has occurred to us that advance information could readily

properly camouflaged so they will have a rather innocent appearance. In other words, they could be made up as cobblestones, pieces of log, or any other object that would not arouse the suspicion of the enemy. It would then be the duty of some of the men to take these thus camouflaged sensitive microphones up to the very edge of the enemy's trench, concealing the microphones behind his parapet and sand bags.

Needless to say in doing so, it is necessary for the party who lays the microphones to clear the barbed wire entanglements, and this is ticklish business. Inasmuch as these wire entanglements are often provided with cowbells and other ingenious tell-tales which immediately inform the enemy that someone is near, the trick can be accomplisht nevertheless. For instance, the microphone may be thrown by hand like a bomb, taking good aim that it does not actually land into the trenches; thin wire trailing from behind the microphone and which should have the same color as the ground, will not be readily detected by the enemy. In this case, the wire would of course lay on top of the barbed wire entanglements, but being very fine it probably would not be observed from the enemy's trench.

Naturally all this work must be done during a dark night, it being impossible to crawl out of the trenches in "No Man's Land" during the day-time without courting certain death. It also goes without saying that the enemy will surely discover some of the microphones in time and shoot them to pieces.

However, it should be possible to place enough of them in such a manner that at least a few will stay in place where they

how the microphone is thrown, it should operate to its full sensitiveness. This, however, presents no unsurmountable technical difficulty, any electrical engineer being capable of designing a microphone of this kind.

Now suppose we have a few dozen of these microphones concealed near the enemy's trench. The wires from them lead to our own trenches, where an operator is to be in charge of the receiving end, listening for any information coming over his wire; chance remarks by the enemy are surely to be made from time to time. But not alone is information such as this of high import, but our commanders need very much more certain information as for instance, when the men in the first trench line are to be relieved.

In trench warfare, the men of course cannot stay in the trenches all of the time, and they are usually relieved during the night-time, which means more or less confusion, "choked" trenches, etc. If our attack can be timed at such a period, it is naturally more easy to win a trench than when the regular forces are in charge. The noise and the talk of the relieving party should usually be loud enough to give such information away over the sensitive microphone.

Of course, a scheme of this kind can readily be improved upon in many ways, and we leave this to our able Signal Corps attendants at the front.

ITALY USES RADIO-TELEPHONES

So successful have wireless telephones proved on Italian warships that the government plans to install them on merchant and passenger vessels.

"Movies" Show Women's Place in War

IN these trying days of strife when on all sides nations are in the grip of war the "movies," as usual, have their full play on the subject. Always of keen interest to young and old, kiddies as well as grown-ups, the photoplays are giving their best to the portrayal of war in all its grim reality. Every detail receives the utmost consideration; especially is this true where the uses of electricity and modern invention are involved.

From the large number of photoplays now before the public the following essay and photos have been chosen, showing how women may help at home, by "Taking the Man's Place," and by so doing, allowing every brave and true-hearted American an opportunity to do his bit in the fight for democracy. The following is typical of the change that has been wrought abroad at the present time, and who knows, but what the same might happen in the good old U. S. A. Lady "W," at the beginning of the war, lived in a palatial mansion in an exclusive section of the big metropolis. She sipt her coffee in bed every day at noon, motored about the English capital and gossiped over her tea with other ladies every day at dusk. At dinner she became finical over the *filet mignon*, after which she drove to the opera or to a social function given by one of her friends. She was the kind of a woman who thought life impossible without two maids at least, a manicurist and some one to look after her pet dogs.

Recently one of her friends received a letter as follows: "I shall soon go into the fields, and 'do my bit' along with the other women who have turned farm laborers. Ever since the horror of this war first broke on me, I have done everything that I could to alleviate the suffering of the poor boys who are stricken by it.

"My home, as you already know, has been turned into a hospital. I, myself, have nursed many wounded men back to health. I have spent days and often nights rolling bandages, mending and disinfecting clothes. Now I believe I am needed in the fields, and I shall probably be among the Sussex dairy maids by the time you receive this letter."

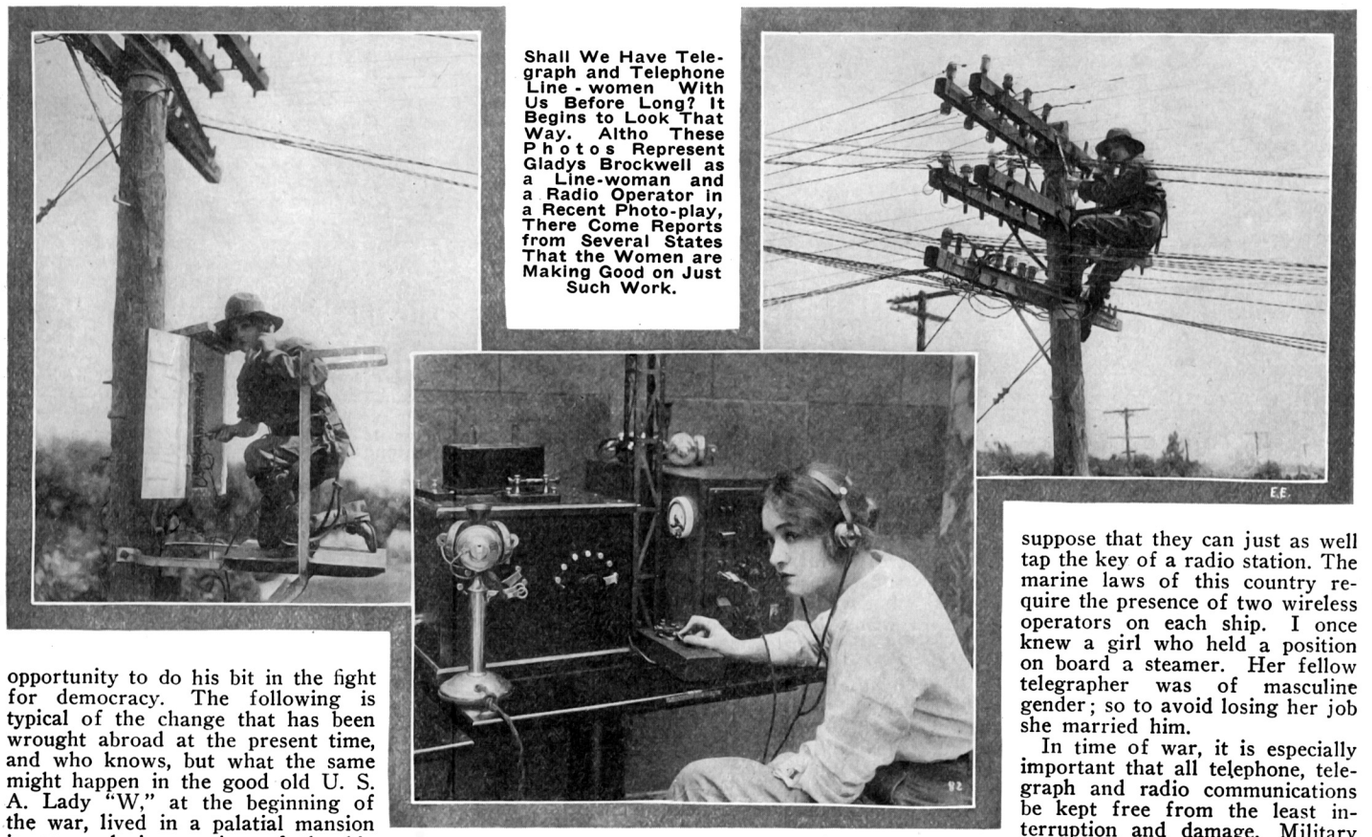
This was the war's effect upon Lady "W." It is typical of what has happened thruout Europe and what must certainly occur in this country, if the war continues two years longer.

Already women are training for various vocations and are replacing our first quota of the Grand Army. As a "lineman," the woman will fit in very nicely, having held the reputation of working wires so long that making a profession of this pursuit will not be new. It is true, they will be very much up in the air about it, as anyone can see from the accompanying photographs, which show a fair female lineman—beg pardon, linewoman—one Miss Gladys Brockwell, in the Fox photoplay, "Taking the Man's Place." Seriously, however, acting as telephone and telegraph linemen is not a completely foreign occupation. Of the 38,000 persons now employed in this occupation, 600 are women.

Many dangers are encountered by the man whose task it is to see that the electrical communication lines are not broken. He must climb to the top of the highest pole, cling among a nest of wires with a narrow belt as his only support. While there, he must see that all apparatus is in working order. He has often to go into lonely stretches of the country, where at any minute, he is liable to be attacked by fierce beasts or still fiercer men. He must also expose himself to rigorous weather and he frequently spends the night among poisonous marsh gases.

All of these hazards the women are willing to encounter. They have heretofore given many instances of moral courage. Physical courage, which is a much commoner thing, they will be capable of showing when the time comes we are sure.

Then again as a "Wireless Operator," the woman can very well fill positions in this interesting and fascinating art. There is a fifteen year old girl now living at San Raphael, Cal., who has received a first grade commercial radio operator's license from the United States Government. Her name is Kathleen Parkin, and she took up the work after becoming interested in it in the physics laboratory of the high school she attended. Wireless operating, in fact, seems to be a form of employment peculiarly adapted to women. Girls hold the majority of places at telephone switchboards and quite a number in telegraph offices, so it seems reasonable to suppose that they can just as well tap the key of a radio station. The marine laws of this country require the presence of two wireless operators on each ship. I once knew a girl who held a position on board a steamer. Her fellow telegrapher was of masculine gender; so to avoid losing her job she married him.



Shall We Have Telegraph and Telephone Line-women With Us Before Long? It Begins to Look That Way. Altho These Photos Represent Gladys Brockwell as a Line-woman and a Radio Operator in a Recent Photo-play, There Come Reports from Several States That the Women are Making Good on Just Such Work.

In time of war, it is especially important that all telephone, telegraph and radio communications be kept free from the least interruption and damage. Military units in widely different parts of the country must be acquainted with the movements of their troops. Orders from the commanding officers must be sent immediately to subordinate officers of the line. Old men and young boys will be incapable for all the jobs, and Uncle Sam will be forced to turn to the women and ask for their help. One thing seems absolutely certain:

When the call comes, the women will be ready!

One of the newest New York hotels is electrically equipt from top to bottom. Hardly an electric appliance of the many which contribute so much to happy, comfortable living has been omitted. Electric refrigerators, dumb-waiters, stoves, fans, vacuum cleaners, 'phones, calls of all description, the most improved and modern lighting, and a host of other electrical appliances. This model hostelry is called Hotel des Artistes, and, as the name implies, is especially conducted for artists, illustrators, writers, and those of allied occupations.

How Big Electric Men Work

By GEORGE HOLMES

EDITOR'S foreword.—The present article, especially prepared for "The Electrical Experimenter," is one of great interest to all of us, and particularly to electrical readers who follow the lives of big men in their reading. It is not often that one has the unusual opportunity of observing at close range just how such men as Edison, de Forest or Pupin accomplish the day's duties. Besides making interesting reading you will find in the following paragraphs some of the principles involved in the working out of these men's goal—Success!

DR. LEE DE FOREST, the well-known radio engineer and inventor, is one of the greatest radio students today. Besides being president of his own company, now extremely busy on war orders, he still finds time to carry on researches in wireless. When I asked Dr. de Forest how he tackled the day's problems, he said:

"My daily work begins promptly at eight o'clock. I first go over my mail and decide what matters require immediate attention and what can be postponed to more leisurely moments. Before beginning my dictation I go rapidly thru the Laboratory and Shop to check up the various jobs and see what progress has been made, and what are the needs in the way of information or advice of the men in charge of the various jobs. This is to avoid any delays which occur if I postpone this work until thru with my office work for the day.

"I then shut myself in the office and endeavor to do at once all the dictating which has to be done for that day. I am usually thru with this work by nine-thirty.

"I then go carefully over the work in the Laboratory, Audion and Oscillion Departments. In these days when we are so rushed to get out instruments of various types urgently needed for the Army and Navy, I frequently help in the testing of the apparatus. I find this keeps me most intimately in touch with the exacting requirements which must be met in this Government apparatus. Occasional faults in design present themselves, or some careless or hasty work on the part of some of the employees which must be corrected before it goes further.

"About noon I am usually ready to make a second trip of supervision thru the factory. Lunch hour consists of eating a few sandwiches while seated at my desk, and usually consumes less than fifteen minutes. This affords me a good opportunity to check over my memoranda as to various matters which will require my attention during the afternoon.

"It is frequently necessary, even in these busy days, to go to New York City to consult with my Patent Attorneys, manufacturers, chemists, or engineers with whom we are doing business or obtaining materials from. These outside trips are always confined to the afternoon and I make every effort to so arrange them that I can get back to the factory before closing time in order to go over all the mail of the day, checking up and signing the correspondence, and laying out the necessary tasks which are to be undertaken the next morning.

"The present program permits practically no experimental or research work during working hours. All such work has to be now limited to nights and Sundays, altho it is really surprising how much of this development work can be done here and there between times when testing out standard apparatus, etc., provided only that this development work is along strictly similar lines, such as improvements in the design of Audions, or Oscillion tubes, refinements of circuits, improvement in mechanical and electrical designs, etc.

"Under these circumstances most of the details of data-making, quantitative measurements, etc., must be left to my assistants whose time can be uninterruptedly devoted to their individual tasks.

"My reading and study work are limited to hours at my home, which fortunately is located fifteen minutes by automobile from my Laboratory. This work is always done at night and is usually terminated between eleven and twelve o'clock.

"It is a source of genuine regret that in these exceedingly busy and strenuous times my duties do not permit me to concentrate as has been my habit and delight for days and weeks at a time on some problem or investigation. It is only by such concentration that revolutionary results are obtained but under the circumstances which surround us this form of work must unfortunately be postponed to more tranquil times."

PROF. MICHAEL I. PUPIN of Columbia University, a striking figure in the electrical world and instructor of Electro-Mechanics at that Institution, is an unusually busy person as is general with men in the public eye. His pleasing personality and good will towards all who know him is remarkable, when one considers the numerous tasks that confront him in the course of a day.

Aside from the various classes at the University and time devoted to various technical meetings, etc., he still has time for experimentation and research. At the time of the author's visit to his wonderful laboratory at Columbia, Prof. Pupin and his assistant were engaged in experiments on a new form of rotor for high frequency alternators.

Regarding his general layout or plan of work, he said among other things—"That 'Big' men do not plan out their day's work, but just take it as it comes"—which saying is very true when one considers the numerous problems that arise daily in the work of such a man. Of course, there is always a schedule kept as to the classes to come and the series of experiments to be conducted, but usually there is much that has to be taken care of just as it comes.

Taken all in all, Prof. Pupin is one of the busiest personages ever interviewed. However, from appearances one would never judge him to be one of the leading scientists of the day, as he takes his work coolly, quietly and deliberately, even in the most strenuous periods and is always pleased to meet a fellow experimenter and chat for a few moments on topics of electrical and scientific interest.

THOMAS A. EDISON, master electrician, chairman of the United States Naval Advisory Board, holder of more patents than any other man living, inventor of the incandescent lamp, phonograph and motion picture machine—how does such a dynamically active human genius get thru the day's work?

In answer to this question as to the routine followed by Mr. Edison in going thru the day's work, it may be said that the term "routine" would scarcely be applicable in his case. In other words, Mr. Edison usually has in progress a number of investigations and experiments which he is either conducting in person or with the aid of his large staff of experimenters.

One or more of these investigations or experiments may be the subject of a strenuous campaign continuing day and night without intermission, while others may be along lines of work requiring months and in some cases even years of experimentation. As an instance of the latter class, there was one case where Mr. Edison had an expert experimenting upon one single line of phonograph recording, under his supervision, for 15 years before arriving at satisfactory results.

Altho Mr. Edison is a good business man, as well as an inventor, he does not keep a calendar of engagements, Directors' meetings, et cetera, but figures on having all the time there is, day and night, for his experimental and inventive work, leaving it to his son, Mr. Charles Edison, and his assistant, Mr. W. H. Meadowcroft, to watch out and see that he attends to the comparatively few appointments that have been made for him.

He never attends to the details of opening any mail. There is a tremendous stream of letters flowing to him constantly, but these are opened for him, and only those requiring his personal attention are brought to his notice. His assistants strive to save him in every detail that is possible, especially when he is on one of his strenuous campaigns, during which he will often average 20 hours work a day for a long period of time. During these campaigns everything is boiled down to the extreme point, in order that he may be enabled to concentrate his attention on the work in hand to the utmost possible limit.

His days and nights are crowded with work, and he has no regular schedule that could be called routine. He devotes all his thought and energy to the work which is in hand at the time, and he has no thought whatever for the clock.

Ordinarily, he comes down to the Laboratory right after breakfast and plunges immediately into work the moment he arrives, oblivious of all else that is going on around him. It must be noted, however, that he will find time to keep in close touch with his extensive business interests by occasional consultation with the various managers and a rapid examination of reports of the operations of the various departments, his capacious memory enabling him in this way to keep his finger on the pulse all the time.

No man exists who is happier than Mr. Edison when he has some new problems to solve.

Something New in Microphones

THE microphone or sound wave transmitter now used in all standard telephone and similar apparatus, has, to all practical intents and purposes, remained the same for many years in its general make-up. That is, it has comprised a metal or mica diafram about three inches in diameter, and when the voice waves in the air impinge against this diafram, they cause it to vibrate on its full diameter as an axis. When this occurs, a small carbon button, secured to the center of the diafram, is caused to exert a varying pressure against a number of small carbon grains held in a carbon cup in juxtaposition to the aforesaid carbon disc carried by the diafram. The accompanying illustrations show something quite new in the realm of microphones, which has just been invented by William and James Birrell.

The new transmitter here illustrated is the result of much research work by these engineers, who have made a close study of this instrument, and its operating principle is rather one of *agitation* of the carbon granules between the carbon electrodes, than it is of *compression,* as in the old type.

It is quite remarkable what this new form of microphone will do. For instance, the diafram may simply be held in the hand as shown in one of the accompanying illustrations, and the transmitter will talk loudly and clearly over a telephone circuit of considerable length. It has been tested out on actual telephone circuits up to 107½ miles in length; this circuit consisting of 100 miles of standard metallic line and 7½ miles of farm line, which latter was mostly barbed wire fence. In another test, on a telephone train dispatching circuit near Chicago, this transmitter was successfully tested out on a 443 mile stretch of line, and the voice was remarkably clear and distinct, regardless of the fact that a number of train dispatching telephone stations were connected in on the line at the time.

This transmitter can be placed in any standard telephone microphone chamber, such as found on desk stands or wall 'phones, and all that is necessary is to remove the old transmitter parts, including the bridge arm, and placing the new transmitter of the type herewith shown inside the chamber, using the old damping springs which had been left in position, as the means of holding it in place. With this simple change, and connecting one cell of dry battery at each end of the line, into which 35 miles of cable had been connected, the spoken voice emerged clear and distinct.

One of the illustrations herewith produced shows an interesting and most remarkable test made with this transmitter, in which it was submerged in a small fish aquarium filled with water, and also containing several gold fish. Wonderful to relate, and contrary to what might invariably be expected with such a delicate device as the microphone, this particular instrument succeeded in transmitting the voice perfectly thru 35 miles of artificial cable, while it was submerged, and moreover, *with the mica disc covering the carbon grains punctured, so as to allow the water to enter the carbon cup.*

One of the illustrations herewith, shows a young lady making this test, the sound waves passing first thru the air and then thru the water to reach the submerged microphone.

With respect to the resistance of this new microphone, a number of tests gave its value at 50 ohms, when the receiver was removed from the hook, and with no talking or other noise in the vicinity. As soon as voice waves impinged on the transmitter, its resistance increased to from 105 to 110 ohms, and it proceeded to vary between 110 ohms and 60 ohms, the resistance not returning to the normal 50 ohm value at any time. The current consumption with four dry cells in circuit with the microphone, varied from .09 ampere with no talking to .04 ampere when talking started. When but one dry cell was tested in circuit with the microphone, the current consumed varied from .02 ampere to a little under .01 ampere.

Most important of all, this microphone is one of the simplest, if not the simplest ever devised, considering its extremely high efficiency; which compares favorably with any of the standard microphones now in use. It has but twelve parts in its make-up, and the arrangement of these parts is apparent from the accompanying photograph. One of the most interesting facts about this transmitter is that *no mouthpiece is necessary,* even when talking over long circuits with it, as is invariably the case with all of the usual microphones with which we are familiar.

Left: Even When Submerged the New Transmitter Gave Perfect Transmission Thru Surface of Water. Center: A Casing Is Not Required for Talking. Right: Front and Rear Views of New Microphone Showing Construction Details.

WOMEN ELECTRICAL ENGINEERS.

One hundred and fifty young women will study to become electrical engineers at the State Agricultural College of Kansas the coming year. Because of the war many engineers have left their positions and it will not be a great while before the shortage will be keenly felt. "Women are being employed as power plant operators in the large central stations of Europe," said Clarence E. Reid, professor of electrical engineering at the college, "and have been found entirely satisfactory.

"None of the machinery in these stations is operated by hand, but is all controlled by various forms of electric motors set into operation by the touch of a button or by electro-magnets or air pressure controlled in the same manner, so that physical strength is not at all necessary. Work of this kind is far less exhausting than many forms of work in which women are now engaged, for central station operators may use seats and have more variety of movement in their work. Desirable qualifications for entering upon engineering study comprise ability in mathematics and interest in scientific study."

Electrical heating blankets are now offered to those who sleep out-doors, for hospital and sick-room use, for elderly people or those with poor circulation. These blankets come as large as 6 x 5 feet; have three temperature controls, ranging from 82 to 112 degrees. The cost of running is almost negligible. The item of lightness as compared to much heavier bedclothes is an important consideration.

HOW AFRICA GETS THE WAR NEWS.

The war has, from the first, been brought right home to Africa. The four German colonies, over which the war extended, have an area more than four times as great as Germany; and there has been long and hard fighting in all of them except in Togo. Outside and within these areas of actual warfare live thousands of whites who are intensely interested in the European struggle. It may surprise many to know that not a few of these whites, even in the depths of Africa, are receiving the essence of the news every day and are well informed as to the most vital facts of the day's war history.

Even the Sahara Desert is now partly belted by a telegraph line, a French enterprise, with wireless extension to Timbukto. Thus this once mysterious city of the Sudan is now in touch with the great events of the day. The Belgian Congo is efficiently served by the French cable to Libreville and the land line to Stanley Pool, where navigation of the Upper Congo begins. The news is then wired up the Congo to the mouth of the Kasai River, 370 miles above the mouth of the Congo, and then by wireless to Stanley Falls, 870 miles above the Kasai.

THE MAN WITH THE MAGNET.

Almost, if not equally, as famous as the immortal "man with the hoe" is the "man with the magnet"—the man we see in all of the leading industrial plants now-a-days. The illustration shows a powerful 12-inch electro-magnet handling a 1,500 pound steel billet in the plant of the Duplex Metallic Co., Conshocken, Pa. It lifts the billet just as easily as a man would lift a 25 pound sack of flour. At the touch of a switch the magnet loses its magic power and the billet drops or lays where it is. Attached to traveling cranes, the amount of work one of these electro-magnets in the larger sizes can accomplish in one day is quite astonishing. They will unload a freight car full of pig iron in less time than a gang of men and at a fraction of the cost. The larger sizes of electro-magnets are capable of lifting single pieces weighing as much as 60,000 pounds, or 30 tons. Such a giant electro-magnet as this measures 62½ inches in diameter, consumes 72 amperes at 220 volts, and weighs 7,500 pounds, net.

Here We Have the "Man With the Magnet," Who Is Almost as Famous Nowadays as the Immortal "Man With the Hoe." The 12-Inch Electro-Magnet Is Shown Lifting a 1,500-lb. Steel Billet.

ELECTRICITY AS FOOD: MR. HOOVER PLEASE NOTE.

M. Bergonié, the eminent French doctor, has solved the high cost of living by means of diathermy. In other words, he claims to have made electricity take the place of food. Applications of the electric juice will furnish the body with nourishment. He has tried his idea on a man weighing only 110 pounds, who had not been receiving sufficient nutrition. In a short time this man was fat and sassy. Electricity did it. It furnishes the heat for the body which is usually furnished by food.

The poor man who owns an eighty horsepower Mercedes and cannot afford to buy food and gasoline both, and is slowly starving to death, can go out in his garage and three times a day, disconnecting the wires of his storage battery, can consume all of the electricity that he needs. This will take the place of breakfast, dinner and supper, or breakfast, luncheon and dinner, depending, of course, upon the man's station in life. When an automobile party is stranded nineteen miles from a garage all of the members of it can be fed from the batteries in the car.

Whole families may be fed from an electric lighting chandelier in the parlor and this will save the trouble of cooking. And then electricity will not smell up the house like corned beef and cabbage does.

However pleasant it would be to get a breakfast from an electric belt or get a ten-course dinner from the batteries in the telephone, we fear there is a catch in it somewhere and it will probably be some time before powerhouse banquets will become a reality.

TELEPHONE IN COCOANUT STARTLES NATIVES.

Modern home comforts are not exactly familiar to Sulu Islanders, according to a report publisht by the Society for Electrical Development.

From the Philippines Comes an Interesting Electrical Stunt That Fooled the Islanders. The Yankees Simply Dropt a Telephone Receiver in a Cocoanut Shell, Which Hung Outside the Building. When the Cocoanut Started to "Talk"—Well, Say.

"While in the Government employ in the Philippines," says this writer, "I was stationed on the island of Pasilan, which is a small island in the Sulu Archipelago.

"We frequently had them entertain us with their native dances, and in turn would fill them with wonder and awe with a phonograph which we had in our outfit. We found it necessary to put up a telephone line between two buildings that were a little distance apart, using two magneto sets. One day I found a rather large cocoanut under a tree near the bamboo hut we were living in, and conceived the idea of making a cocoanut talk. So I emptied its contents and hung it on the outside of the house opposite the phone, so arranged that we could put the receiver thru the grass wall and drop it into the cocoanut.

"We invited some of the natives to see the wonderful cocoanut that we could make talk, and with the aid of an interpreter at the other phone who understood their language, we had a lot of fun. Some of the natives were so frightened they left the village. Next day a delegation returned and directed us to destroy the talking cocoanut, under penalty of immediate attack. They did not like to have so uncanny a thing around. There was much rejoicing when we consigned it to the flames.

Historic Electric Apparatus

By H. WINFIELD SECOR,
Assoc. A. I. E. E.

THE present article is an endeavor to refresh the minds of our electrical students with the antecedents of the wonderful present-day electrical inventions. Like every invention or science, the art of electricity has had its full share of struggling inventors and laugh-producing inventions.

The early inventions in electrical science here discust are not necessarily the very first effort made in each respective line, but are those which are given credit historically, being the fundamental ones from which all later practical applications developed.

One of the first electrical phenomenon experimented with, was that of *static electricity*. Fig. 1 shows the first static machine as devised by Otto Von Guericke, of Magdeburg, Germany, in the year 1630. The illustration shows Von Guericke and also his machine, which consisted of a globe of sulfur fixt upon a rotatable spindle so that it could be revolved rapidly by means of a crank. Powerful static electric shocks were obtained from this relatively crude device by pressing against the surface of the sulfur ball with the hand, while it was being turned.

In the present article, describing historic electric apparatus, you will find many facts not generally known. For instance, did you know that the first electric telegraph was actually worked in 1774, by Le Sage, a Frenchman residing in Geneva, Switzerland?

Did you know that incandescent electric lamps, employing a carbonized paper filament burning in a vacuum were successfully constructed as far back as 1845? This lamp was invented by a Yankee—Mr. Starr of Cincinnati, Ohio. The first successful arc lamp with automatic carbon feeding mechanism was built about the same time, by an Englishman named Wright. The history of these electric inventions is a real romance.

The *Voltaic pile* illustrated in Fig. 2 was invented by Alessandro Volta in 1775. This device was the first to produce what is properly known as *voltaic* (also called galvanic) electricity. This battery was made by placing a pair of discs of zinc and copper in contact with one another, then laying on the copper disc a piece of flannel or blotting paper, moistened with brine; then another pair of discs of zinc and copper, etc., each pair of discs in the pile being separated by moist conductor. Such a pile, if composed of a number of such pairs of discs will produce electricity enough to give quite a perceptible shock, if the top and bottom disc terminal wires be touched simultaneously with the moist fingers. Volta is given credit for laying the foundation of all present day batteries.

The first *electric telegraph* of which we have historic record, and also that on which most writers and authorities agree, is that of George Louis Le Sage, a Frenchman residing in Geneva, Switzerland, and who built his first telegraph in 1774. The Le Sage telegraph system employed 24 wires, placed in a trough in the ground, the wires being suitably spaced and insulated by means of glass partitions at frequent intervals. Each wire represented a certain letter of the alphabet. As is known, gold leaf is extremely sensitive to minute electric impulses, and so we find that Le Sage placed a small piece of gold leaf at the end of each wire. To send a signal over any particular wire corresponding to a certain letter of the alphabet, a small static charge was sent thru the wire by touching it at the transmitting station with a glass rod which had previously been electrically excited by rubbing it with silk. This system was rather limited in its application, as it is very difficult to insulate a static charge for any great distance.

The next serious form of electric telegraph devised was that of Soemmering, bearing the date of 1808, Munich, Germany. This is the machine illustrated in Fig. 3. It operated on a very ingenious principle; viz., that of the electrolysis of water by the passage of an electric current thru it. This inventor used a wire for each letter, the same as Le Sage, and to send a signal over any certain wire, but the wire in this case could be of considerable length. With this system it was but necessary to pass a small battery current thru the proper wire, which caused the water in the indicating device at the opposite end of the line to be decomposed, this indication being evidenced by the production of a large amount of (hydrogen) gas bubbles in the water.

The first *electric motor* is undoubtedly of interest to every electrician. Early in the 19th century a number of philosophers became much interested in the effect of electric current carrying conductors, especially in their reaction when placed in the field of a magnet. With respect to the first electric motor devised, credit is invariably given to Michael Faraday, who devised the first electro-magnetic rotation apparatus in the year 1822. Barlow in 1823 produced the rotation of a star wheel placed in the field of a strong magnet as shown in Fig. 4. These devices were very crude and simple however, and developed infinitesimal power. Undoubtedly the first electric motor employing electro-magnets wound with many turns of wire, and also comprising a motor which utilized both permanent steel magnets and electro-magnets, was that perfected by Prof. Joseph Henry, of Princeton University, in the year 1831. Henry produced *reciprocating* motion as well as the *rotary* motion by electro-magnetic means. Henry's motor of the vintage of 1831 is also shown in Fig. 4. This was the forerunner of the present-day electric motor of which there are many hundred thousands in use in all parts of the world. Henry's device interrupted the battery current by its oscillating or rotary motion in an intermittent manner in either case. It is interesting to note that Henry called his motor a "philosophical toy." In studying the history of electric motors and dynamos it is well to keep in mind this first electro-magnetic motor of Professor Henry's, which fact will be further touched upon in the present article, as it had a very important bearing on certain other inventions.

The *dynamo*, which produces electricity by rotating an inductor or series of inductors in the field of a powerful magnet, was first studied on the basis of a peculiar phenomenon. The first experiment in this field reverts back to what is known as Arago's disc. This consisted of a brass or copper disc which, when rotated at considerable speed and placed below a magnetized compass needle, caused that needle to be dragged around. These "Arago's rotations," as they were called, were supposed to be some kind of mysterious *magnetic rotation*, until Faraday proved them to be due to induction and simply obeying a basic law of electro-magnetism. The next definite step in the development of the dynamo as a producer of electricity by electro-magnetic means was in 1831, when Faraday made his first experiments with a revolving copper disc placed between the poles of a very powerful magnet. In some of these experiments, a copper disc was allowed to dip in a trough containing mercury; the electric current being taken from the axle supporting the disc, and from the mercury trough in which the disc dipt as it was rotated by means of a crank handle.

About a year later Pixii devised an electro-magnetic dynamo as shown also in Fig. 5, which involved the use of a revolving permanent steel-magnet placed below two iron cores containing coils of wire. By means of driving gears and a handle as shown in the illustration, Pixii was able to produce quite strong alternating currents with his dynamo as the permanent magnet spun around below the magnet coils at high speed.

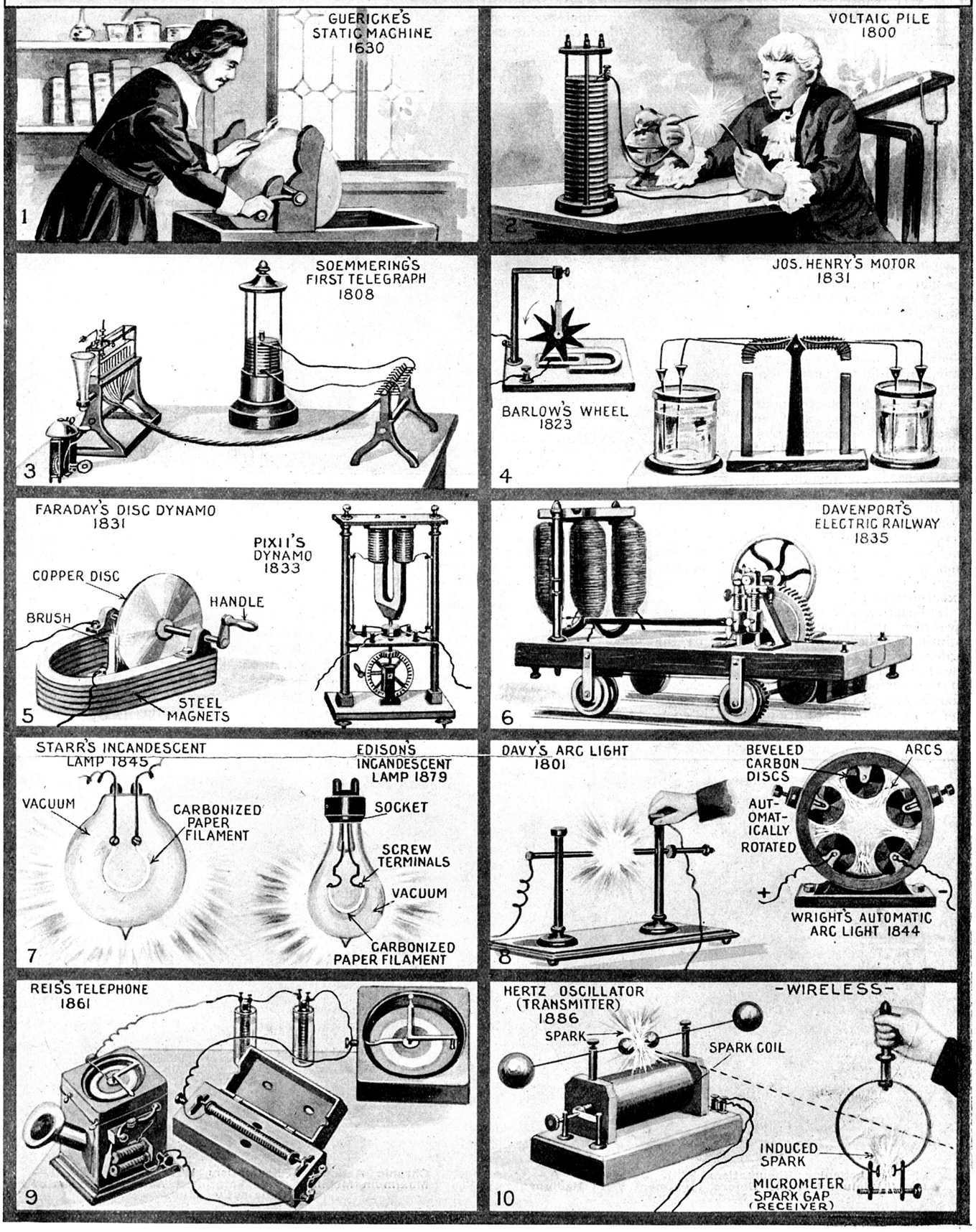
The *trolley car*, with which we are all familiar today, and which moreover seems so simple that it would almost appear to have always been with us, instead of passing thru many stages of evolution, was distinctly an American invention. Going back to the work of Prof. Joseph Henry and the electric motor, it is recorded that Thomas Davenport, a New England philosopher who was residing in Vermont, went to see one of Prof. Henry's powerful electro-magnets in operation at a manufacturing plant where the magnet was in use for the purpose of removing iron from clay and other materials. This was about the year 1833, and Davenport was much imprest by the great power of the then new electro-magnets, one of which he saw demonstrated by lifting a heavy steel anvil when excited by three battery cells.

Davenport did much thinking on this subject and at once started building models of electric motors, and he is given credit for producing the first electric railway in 1835. History records that Davenport actually made *over one hundred models of electric motors* in the period from 1835 to 1840. These included motors of every conceivable type and variety, both with electro-magnets and permanent magnets. He exhibited an excellent model of his proposed electric railway in Boston in 1840. Davenport, so we learn, was not an educated technician or true philosopher of the college-bred type, but was a natural born genius, and it is said of him that he surely realized the wonderful basic principle which underlies every electric motor and dynamo today; *i.e.*, that to obtain the maximum and most satisfactory results, there shall be two distinct magnetic fields employed, one of which shall be of *permanent polarity*, and the other of which shall be of *constantly changing polarity*.

The first *incandescent electric lamp* has been a bone of contention for a great many years, and much mystery surrounds the early days of the incandescent lamp. Most historical electrical treatises give credit for the first incandescent lamp to Sir Humphrey Davy, who exhibited this type of illuminant (first demonstration in 1802) in

(*Continued on page* 499)

HISTORIC ELECTRIC APPARATUS



(For descriptive text see opposite page.)

The Marvels of Radio-Activity

By JEROME S. MARCUS, B.Sc. (Ch. E.)

PART III.

Emanations.

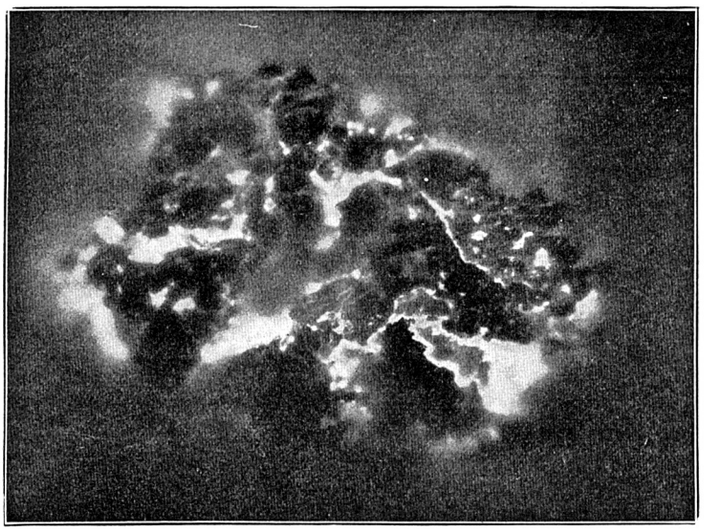
THE substances Thorium, Actinium, and Radium possess, in addition to the ray-giving properties, that of emitting continuously a radioactive gas or *emanation*. These emanations all possess the property of ionizing a gas and, if sufficiently intense, of producing marked photographic and phosphorescent action.

The activity of the radioactive gases is not permanent, but disappears according to a definite law with time, namely a geometric progression. (See Fig. 1.) The emanations are distinguished by the different rates of losing their activity. The length of time necessary for the activity of a given amount of substance to drop to half value is called the "period" of the substance. The Actinium emanation has a period of only 3.7 seconds, Thorium emanation—54 seconds, and Radium emanation—3.9 days.

An Actinium compound wrapt in a thin paper and placed on a screen of phosphorescent zinc sulfid will, in a dark room, show the phosphorescence surrounding the active body on all sides. A puff of air will remove the emanation and the glow dies out, but fresh emanation is given off and the glow reappears. (Due to the present high price of rare chemicals, this experiment will prove too costly for the average experimenter.)

Radioactive waters derive their properties from the emanation held by them in solution, gathered by the passing of the water thru and over rock matter containing radioactive minerals. But on coming to the surface the emanation is released and decays. So it is evident that the "radium waters" advertised are in the main common fakes, and the only way to drink real radium waters and to derive the therapeutic values is to get it at the spring.

Emanations are similar to all other gases —they can be transferred by gas currents, and can be separated from air or other gases by extreme cold and condensation. Rutherford and Soddy showed that under ordinary conditions the temperature of condensation of Radium emanation is—150 C. or 240 degrees below zero Fahrenheit.



A Piece of Pitchblende from St. Joachmisthal Photographed By Its Own Rays. The Pitchblende Was Spread Evenly Over Black, Opaque Paper Covering the Photographic Plate.

Radioactive Changes.

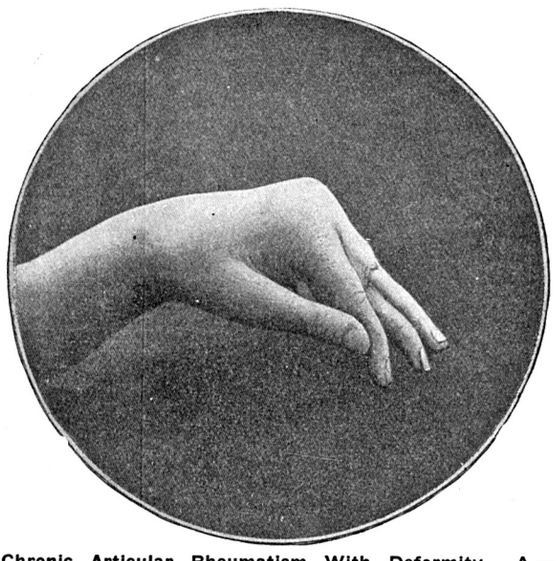
As has been said before, the radioactive materials in giving off rays change into entirely new and distinct substances, *e. g.*, emanation results from the element; another substance results from the emanation. While in the majority of cases the products break up either with the emission of the *alpha* or *beta* particles, some "rayless" ones have been found by scientists.

These different products decay according to their periods, but are constantly being formed by the next lower material, hence an equilibrium will be obtained. The effects generally noted in the study of radioactive materials are then, the combined effects of all these products in an equilibrium of activity.

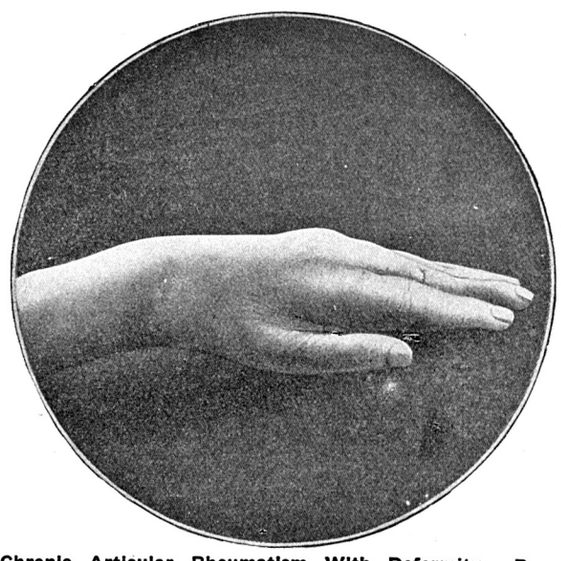
These products differ physically and chemically from the parent matter. The radiation is due to the atomic structure, or better to the atoms themselves, as the most powerful physical and chemical agencies have no effect. In 1903 Rutherford and Soddy put forth the following simple explanation: —The atoms of the radioactive matter are unstable, and each second a definite fraction of the number of atoms present breaks up with explosive violence, in most cases expelling an α or β particle with great velocity. As an illustration, if an α particle is expelled during the explosion, the resulting atom has decreased in mass, and possesses different physical and chemical properties than the parent atom. So a new substance has appeared as a result. Now, this new matter is itself unstable and it in turn breaks up, the process going thru the series until a stable atom (*i. e.*, one stable to our conception of time), is reached.

The breaking-up process has been figured out mathematically and reduced to a law of radioactive change which is applicable without exception to all radioactive matter. It appears to be an expression of the law of probability, for the average number breaking up per second is proportional to the number present.

Looked at from this point of view, the number of atoms breaking up per second

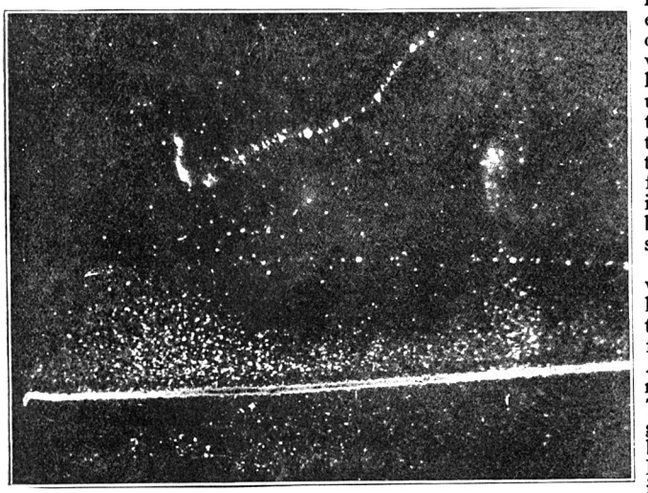


Chronic Articular Rheumatism With Deformity. A.—The Maximum Mobility Before Treatment With Radium Mud.



Chronic Articular Rheumatism With Deformity. B.—Maximum Mobility After Treatment With Hot Packs of Radio-active Mud.

should have a certain average value, but the number per second should vary from second to second within certain limits according to the law of probability. This variation in the number of atoms breaking up from second to second becomes more marked in the weakly radioactive matter, where only a few break up per second.



Representation by Wilson of the Difference Between the A- and B-Rays Very Plainly Shown. In the Middle, a B-Ray of Extreme Velocity with Very Few Electrons Is Seen.

The following table gives the products, the rays emitted, and their periods:

PRODUCT	RAY	PERIOD
Actinium	Rayless	
Radioactinum	* $\alpha + \beta$	19.5 days
Actinium X	α	11.8 days
Actinium Emanation	α	3.7 seconds
Actinium A	β	36 minutes
Actinium B	α	2.15 minutes
Actinium C	$\beta + \tau$	5.1 minutes
Radium	α	1760 years
Radium Emanation	α	3.86 days
Radium A	α	3 minutes
Radium B	β	26 minutes
Radium C	$\alpha + \beta + \tau$	19 minutes
Radium D	β	17 years
Radium E	β	5 days
Radium F (Polonium?)	α	140 days
Radium G (Lead?)	—	—
Thorium	—	About 10^{10} years
Thorium 1	Rayless	5.5 years
Mesothorium (Thorium 2)	$\beta + \tau$	6.2 hours
Radiothorium	α	737 days
Thorium X	α	3.6 days
Thorium Emanation	α	54 seconds
Thorium A	β	10.6 hours
Thorium B	α	55 minutes
Thorium C	α	Very short (?)
Thorium D	$\beta + \tau$	3 minutes
Uranium	α	5×10^9 years
Uranium X	$\beta + \tau$	22 years
Ionium	α	?
Radium (?)	—	—

* α = Alpha ray; β = Beta ray; τ = Gamma ray.

It is extremely difficult to analyze the change and distinguish the various products. It must be proven that the new substance has distinctive physical and chemical properties, and that the substance under consideration came from the one preceding it, and breaks up into the one following it in the series. In general, some property, either physical or chemical, has been found which allowed the material to be separated and removed, and then studied independently. In some cases ordinary chemical means are used, in others electrolysis, fractional crystallization, differences in boiling point, etc.

An interesting method of separation is that investigated by Russ, Makower, and Hahn, and which depends on the recoil of an atom which breaks up on the expulsion of an alpha particle. The residual atom acquires sufficient velocity due to the shooting out of the particle to escape and be deposited on bodies in the near vicinity. This is especially marked in a low vacuum. For example, Actinium A, deposits Actinium B, by recoil, while the recoil of Actinium C from Actinium B deposits it. So the three can be separated and observed.

Boltwood, in his investigations, set forth a lot of evidence to show that Radium is derived from Ionium, and that Actinium is a further member of the series. This makes the three groups of elements members of one family. Rutherford explains that in some part of the breaking-up there is a complex action and Actinium comes off as a branch. There is, however, no grounds for the connection of Thorium to the other groups.

An Automatic Atomizer of Radium Emanation in the Form of an Electric Table Fountain. The Emanation Thrown Off in a Room Can Be Inhaled.

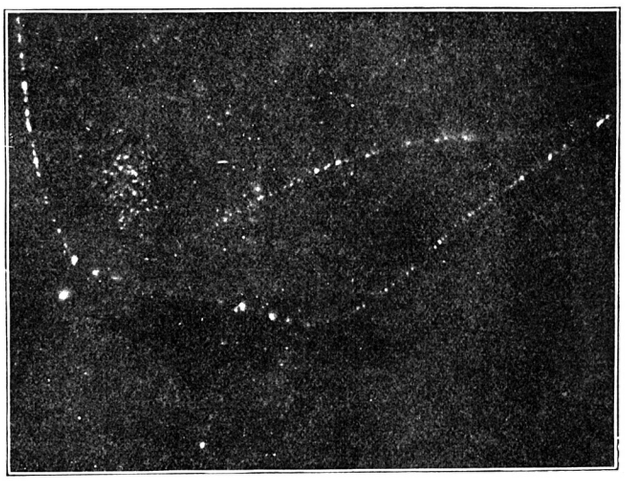
Induced Activity

Curie showed that Radium possest another remarkable property. The surface of any body placed near Radium, or still better, immersed in the emanation, acquires of itself a strange activity. The author has seen a container of Radium salts give all the experimental results of a radioactive substance after the salts had been removed. Like the emanations, this induced activity in a body decays with time, but at quite a different rate from that of the emanation itself.

Rutherford showed that Thorium possest a like property. He showed that the bodies made active behaved as if a thin film of intensely active matter were deposited on the surface. The active matter could be partly removed by rubbing, and could be dissolved off by strong acids. When the acid was evaporated the active matter remained behind.

It was shown that induced activity is due to the emanations, and could not be produced were no emanation present. The induced activity on bodies is due to a deposit on non-gaseous matter derived from the transformation of the emanations, *viz.*, the transformation products as shown in the table above. Therefore, each emanation will give a different deposit with a different rate of decay. The period for

(*Continued on page* 485)



Representation of Electrons After Wilson. The Electrons, Which Consist Solely of Gamma Rays, Have Been Produced From Secondary Beta Rays After Complete Absorption of A- and B-Rays.

SIR OLIVER LODGE ON "ASTRONOMY" VS. ELECTRICAL THEORY OF MATTER.

Sir Oliver Lodge, in a recent technical paper on this subject, gives a number of arguments which are summarized as follows:

1. That motion of matter thru ether has a definite meaning, apart from relative motion with respect to other matter.

2. That an extra inertia due to this motion is to be expected at high speeds, in accordance with the FitzGerald-Lorentz contraction.

3. That this extra or high-speed inertia is not part of the mass, but is dependent on the ether and hence is not subject to gravity.

4. That from this reasonable hypothesis astronomical consequences follow which may be detected when cumulative.

5. That under certain specified conditions merely a small change in eccentricity is to be expected as the chief result, in certain others an apsidal progress or regress is to be expected.

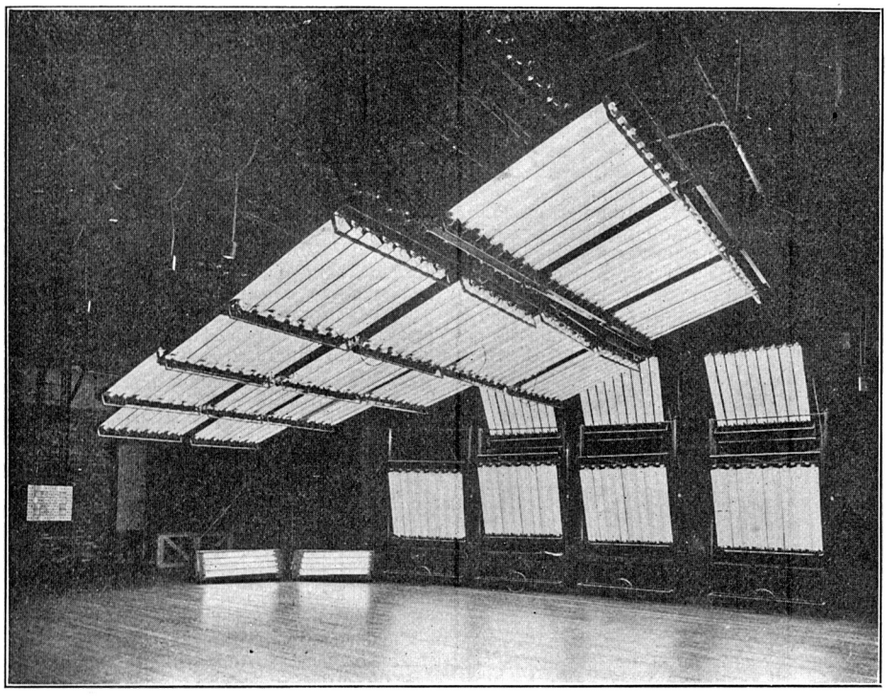
6. That the outstanding discrepancy in the theory of the perihelion of Mercury would be accounted for by attributing a certain value to a component of the true solar motion thru the ether in the direction of the planet's aphelion path.

7. That using this value for the solar-plus-stellar drift, viz., two or three times the earth's orbital velocity, a result can be obtained for the perihelion of Mars, subject to a hypothesis about direction.

8. That by discussion of discordances in the elements of different planets an estimate may be formed of the magnitude and direction of the locomotion of the solar system in its invariable plane.

177,000 C. P. Mercury Vapor Lamps Light "Movie" Studio

On a large stage, the cost of lighting for taking 1,000 feet of film, which would mean about two day's complete work with the lamps on for about two hours, would amount to $7.50 for current and $1.50 for maintenance, or a total of $9 for 1,000 feet, whereas the entire cost of the film may have run from $1,000 to $4,000, depending on the subject. In other words, the best lighting can be obtained on the average for less than one-half of one per cent. of the entire cost of the film. Considering the fact that some actors are paid $1,000 a week and over in salaries, or about $50 per working hour, every single minute of their time that can be saved by proper lighting is instrumental in reducing the total cost of the film.



The Powerful Battery of Mercury Vapor Lamps, Aggregating 177,000 Candle-Power, as Used to Illuminate a Modern Moving-Picture Studio Stage. Over 200 Mercury Vapor Tubes Are Used in this Installment.

Some interesting features are embodied in the recent installation of a complete artificial lighting system by mercury vapor lamps in the new studio where "Rothacker" films are made, in Chicago, especially in the methods used for control and handling of the lighting equipment.

The overhead structure adopted for this purpose consists of a double-girder crane, running on tracks supported by the side walls of the studio and spanning the 52-foot width of the building. The two girders of the crane are separated 26 feet but are rigidly fastened together by a series of I-beams, parallel to the length of the studio, from which the overhead lighting equipment depends. The whole crane system travels on four flanged wheels, moved at present by hand-operated continuous chain and gear mechanism, altho provision is made for electrical traverse.

Overhead, top or skylight effect is obtained from five rows or "skylight frames," each frame consisting of eight 50-inch automatic-starting mercury-vapor tubes with porcelain-enameled reflectors to direct the illumination downward. The back row, that is, the row over the rear of the set and farthest from the camera, has three frames (24 tubes), the second row four frames, the third three frames, the fourth row three frames (one has five tubes only) and the fifth row two frames.

These frames ordinarily slant away from the camera and toward the set, forming a practically continuous plane at an angle with the floor. However, they are not supported rigidly in this position and may, by a simple crank and cable device on each row, be raised, lowered or changed in angle with respect to the floor. In addition to this movement all rows of frames, excepting the second, may be moved on the crane itself, in the line of its travel, to a point where either end frame of any row will assume a position past the side girder. This is necessary to facilitate photographing diagonally across the studio.

Side illumination is furnished by lamps on stands. Four of these are equipt with eight 50-inch mercury-vapor tubes each, three with nine each and two with four each. The entire studio equipment consists of 208 mercury-vapor tubes, aggregating 177,000 candle-power.

A POWER SUBMARINE CABLE.

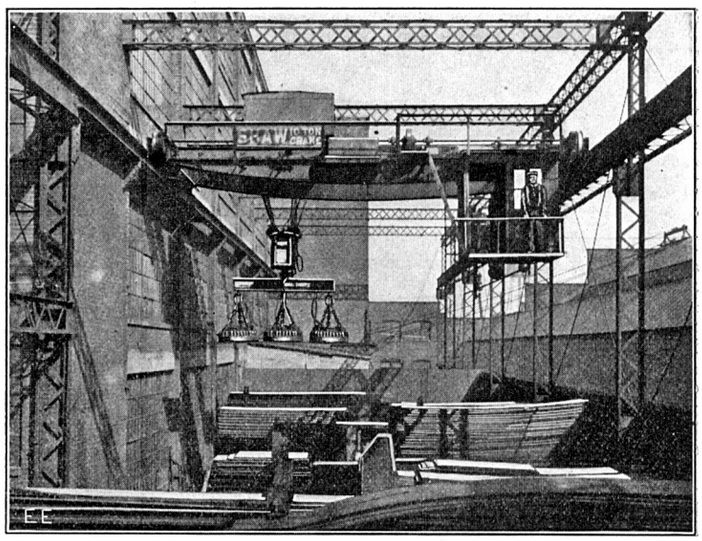
A power cable transmitting power from Sweden to Denmark is the longest submarine cable of its kind, having regard to the pressure at which the transmission takes place. The power is received by the electricity and tramway company at Hellerup, near Copenhagen, and is transmitted by the South Sweden Power Company, at Malmö; the generating power station is on the Lagan River, about fifty miles northeast of Helsingborg. The cable, which is 3.35 miles long, is of the three-conductor type, insulated with impregnated paper. It was tested at the works at 87,500 volts, and carries current at 35,000 volts. The jointing of lead-covered paper-insulated cables at sea is not at all a simple matter, according to *The Electrician,* and all sorts of precautions had to be taken both with regard to regulating the movements of the ship and its laying machinery, and also with regard to the exclusion of moisture from the joints. The greatest depth at which a joint is laid is 120 feet.

AN ELECTRIC CRANE AND MAGNET WITH SWIVELING DEVICE.

By Frank C. Perkins.

The accompanying illustration shows an electrically operated traveling outdoor crane with a clever swiveling device equipt for lifting magnet service at work in an Ohio steel plant. This electric crane has a capacity of 10 tons and a span measuring 29 feet. The upper lifting beam of this crane is equipt with an electric motor, which is under the control of the crane operator, so designed as to swivel the lower beam and load. In order to prevent the upper beam swaying laterally or longitudinally, due to starting and stopping the traveling motions of the crane, or rotationally due to swiveling the lower beam, a special arrangement of ropes has been adopted for the suspension of the upper beam.

It is pointed out that in consequence of these arrangements and of the use of the gigantic magnets, it has been found possible to dispense with the services of a ground man, all functions being performed by the operator in the crane cage, and electric power is employed to great advantage not only for the operation of the crane but for picking up the iron and steel material and its movement, with the least possible manual labor and expense.



To Reduce to a Minimum the Cost of Labor in Handling Steel and Iron Plates, an Ohio Plant Utilizes Three Large Electro-Magnets Suspended From a Swiveling Beam Carried by a Traveling Crane. The Plates Can Be Released in Any Position.

Bucking The "Lodge Goat"—Electricity

TIME was, fellow Shriners and brother Elks, when the always mysterious "degree team" thought they had performed their work well and effectively if they succeeded in scaring the candidate out of about seven years' growth by causing him unexpectantly to fall into a tub full of cold water. But the electrical genius has become legion. Wherefore we find that lodge and other secret society initiations are now really electrifying and the proud candidate is made to actually "feel" that he is "warmly" welcome.

The harmless and extremely amusing electrical stunts for such festivities here illustrated were created in the fertile brain of one John J. Odenwald. He has spent much time in working up these stunts for the use of various organizations and one or more of them will surely prove welcome to any degree team. The stunts are easy to perform and provide a maximum of clean fun.

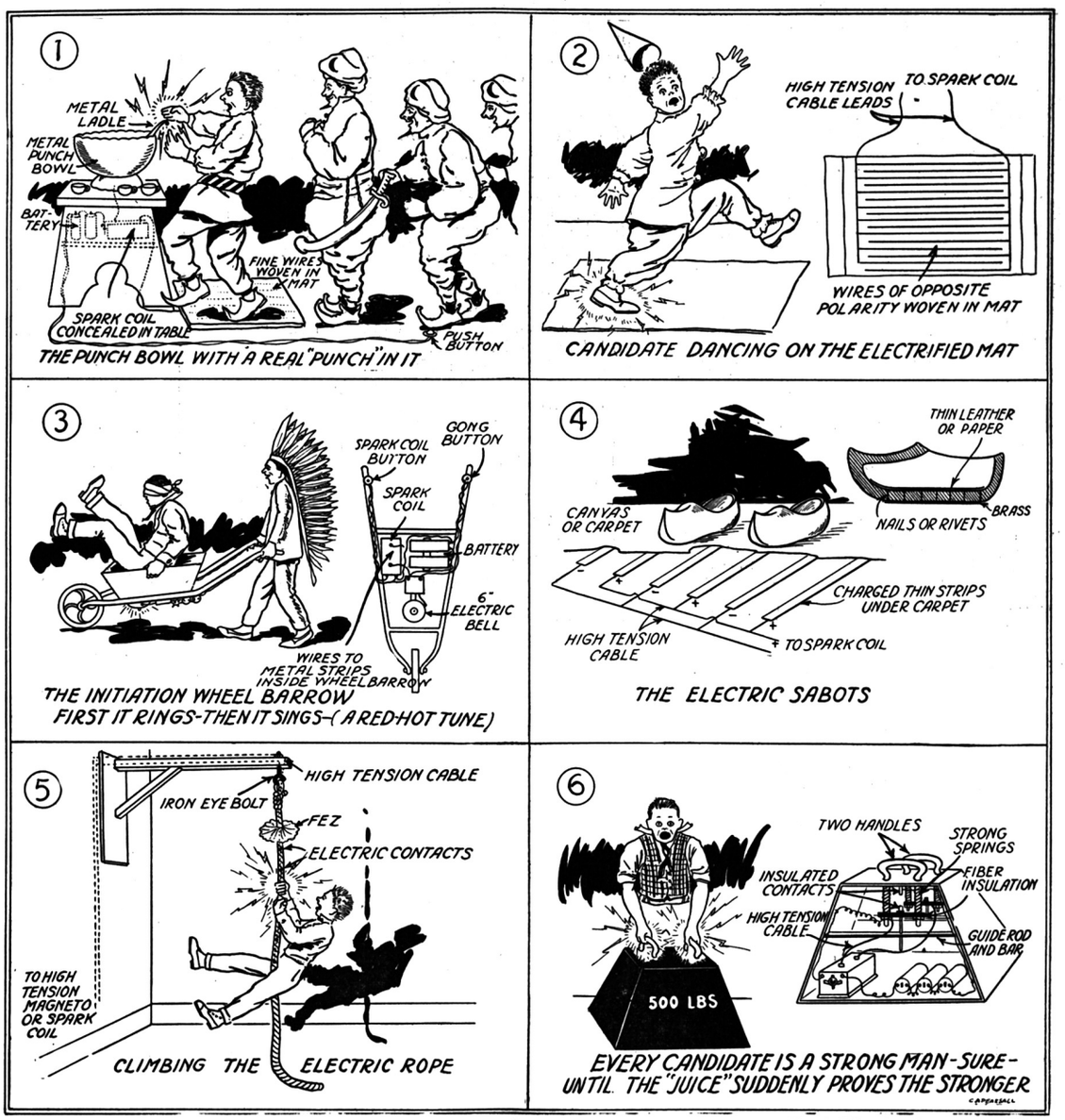
Imagine the gasp of astonishment from the candidate when he serves the punch by special request. "'Tis a proud moment in me life," as Mr. Dooley would say, when Mr. Candidate steps to the punch bowl. Upon touching the ladle he receives a lively electrical jolt which shows him that the liquid has a real "punch." The illustration shows how this trick is readily carried out by means of a small (½" or ignition) spark coil, battery and push button. Use high tension rubber covered cable to connect up the secondary circuit, and if possible do not cross these cables, as "leaks" may develop.

Another is a harmless looking rug in which are woven electrical wires and terminals secretly connected to a high-tension spark coil which makes the initiate do some lively stepping when everything is in readiness.

Then there is the electrified wheelbarrow on which the candidate is brought into the presence of his new brethren. On approaching, the person who is wheeling the barrow quietly presses a secret button in one of the handles which operates a six-inch electric bell to warn everyone to clear the path. This also serves to direct attention to the startling and "shocking" event which happens when another secret button is prest that causes the candidate to arise with great alacrity, due to some very sudden applications of high-tension charges manifesting themselves in the seat of the barrow. Another device is a pair of Dutch sabots, or wooden shoes, which are very harmless looking and yet when worn cause the wearer to suddenly become a dancer of very funny jigs. These wooden shoes are easily charged by placing a metal strip inside and outside of the sole as indicated. These are riveted thru the sole and made as inconspicuous as possible. The inside strip should be covered over with thin leather or paper. Alternately charged metal strips are placed under a canvas covering on the floor. Let the candidate do a few steps—then switch on the current and you will learn some brand new steps that would astonish even Vernon Castle.

Just to prove that the candidate is of good physique, introduce him to the climbing rope, upon which it is customary to place about 15 feet or so above the floor a fez or other suitable object, which the novice is expected to climb to and bring down. After climbing the rope some four or five feet, current from a magneto is suddenly applied to hidden terminals in the rope which makes the candidate come down with considerable speed.

And who doesn't like to pose as a regular "strong man"? Everybody. As a shining light in the initiation festivities we have with us the magic weight—labeled 500 lbs., say. The candidate is introduced to the weight and told he surely can lift it as it is made of a mystic metal, sent from Hindustan. To his surprise he can lift it; but, zowie!! When the handle travels its full length, it throws in a spark coil which lightens his burden at once.



Every Lodge and "Secret Order" Man Will Find These "Electrical Initiation Stunts" of Timely Interest. They Are All Easy of Application and Harmless in Their Effects. The Electric Stunt Can Be Worked Where Clumsy Mechanical "Goats" Would Fail Miserably.

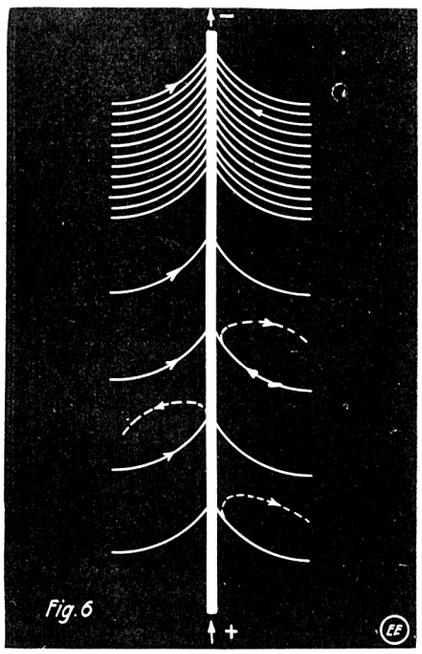
INDIANA UNIVERSITIES TO TEACH RADIO COURSE.

For the young man who inhales with zest the tale of the daring exploits of the wireless operators on the trans-Atlantic liners and the work wireless does in saving ships from submarines the colleges of Indiana this fall have opened up attractive courses. Wireless telegraphy courses will be offered at Indiana, Purdue and DePauw universities and all young men and boys are permitted to enter. The announcement was made today by State School Superintendent Horace Ellis. The work is a part of the war vocational education program.

The Cause and Nature of Magnetic Currents

By F. F. MACE, Superintendent of Public Schools, Dallas, Texas

IN two previous articles, "Magneto-graphs" and "Currents About Magnets," having proven by magneto-graphs and other experiments that there are actual currents surrounding and entering magnets and solenoids, we may now take up the cause and nature of these currents. In the article "Currents About Magnets" it was mentioned that logically we should begin with an experiment in regard to *currents surrounding a charged wire*. We return now to this experiment in regard to currents surrounding a charged wire, where we should logically have begun, and study the origin of these currents, their nature, the creation of electro-magnets, and the logical explanation of the phenomena connected with magnetism.



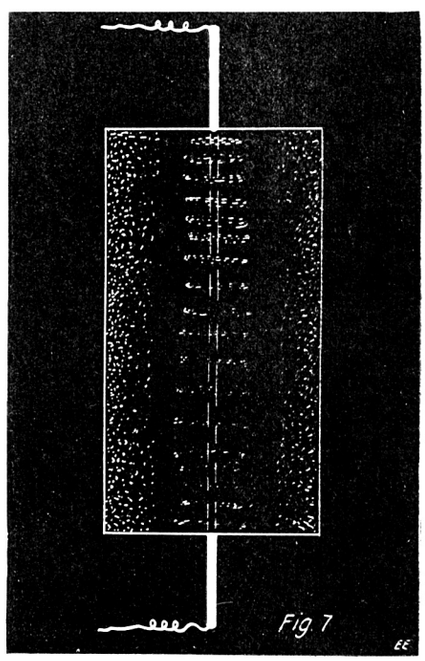
Interesting Chart of the Motions Followed By a Suspended Magnetic Body Near a Charged Conductor; the Body Moves Inward Toward the Wire as Well as Forward, Thus Proving the Existence of Currents Moving Inward and Forward, in the Direction of the Current.

It is well known that a wire bearing a current is to a small degree a magnet: that iron filings will cling to its side. But it has been asserted that the "lines of force" of the magnetic field surrounding such a wire are concentric circles. That under certain conditions they have this appearance, that circular lines of filings may be made to appear about the wire, is not due to any real circular nature of the lines of force, as this circular field is now understood, but to other causes. The real cause of this circular appearance and the true direction of these lines of force—*currents*—will be shown in the following experiment:

Support a wire in a horizontal position and pass thru it a heavy current of electricity. Suspend a small piece of iron wire or a small iron ball by a thread of unspun silk or a hair near, but not touching, the charged wire. The iron will not only be attracted toward the wire, but it will also move forward in the direction which the current in the wire is flowing. Often this motion is such as to form an ellipse, the longer axis of which points diagonally to the wire and forward in the direction of the current's flow, the iron returning along the outer curve. If the position of the thread and the suspended iron be changed along the wire a series of curves will be formed as shown in Figure 6. This, as in the case of magnets, proves the existence of currents moving inward toward the charged wire and forward in the direction of the current flowing in the wire itself.

That these are actual currents is again proven by the photographic plate. Photographic plates exposed above or about such a charged wire under the same conditions used to produce magneto-graphs are darkened everywhere within the field, the degree of darkening shading off towards the edge of the field. Owing to the direction of these currents it is difficult to produce a clear magneto-graph (that is, clear images of objects placed upon the plate), but even this has been accomplished to some extent. Further experiments will probably give better results.

Not only can the existence of these currents be further proven, but it can be shown that these currents are propagated in waves and the amplitude of these waves can be measured. Support a sheet of glass or paper horizontally over a wire and sprinkle upon it fine iron filings as evenly as possible. When an electric circuit thru the wire is alternately closed and opened by means of a key, the filings will be formed into nodes across and at right angles to the wire and the current in the wire. It should be especially noted here that these nodes form at the first closing of the circuit and that they do not change position thereafter, merely becoming more marked with successive alternations by the collection of more of the filings. The appearance of these nodes in the filings is shown in Figure 7. This shows that the current in the wire passes along it in a series of impulses, thus producing a series of similar impulses in the external currents. The production of these external currents is analogous, of course, to the production of currents about any moving body or substance. In sound, when we see nodes formed as in Figure 7, we recognize wave motion and are able to measure wave lengths by the distance between nodes. *In this case, also, we recognize wave motion and are able to measure the amplitude.* It is somewhat difficult to arrive at an exact result on account of the irregularity of the particles of the iron filings and because of their more or less uneven distribution in sprinkling them upon the surface; but careful and repeated measurements and countings show that these nodes average 17.8 to the centimeter, with the current used, and that they vary but little in the distance from node to node. As a node indicates half a wave length, the waves passing over the wire are approximately twice .5618 mm. (i.e., 10 mm. divided by 17.8) or 1.1236 mm. in length. Doubtless more accurate results than this can be obtained and it is barely possible that the wave lengths may be found to vary



An Experiment Made By the Author With Iron Filings Sprinkled on a Glass Plate Placed Over a Charged Conductor, Which Proved That "Wave Motion" Was Present By the Formation of "Nodes."

with the strength of the current and the nature of the conductor used. It is sufficient at this point to show the wave nature of the current in the surrounding field and the approximate wave length. This wave motion, this alternate impulse or impulses, readily account for the concentric circles about the wire. A series of impulses moving upward and inward and repeated at regular intervals and at the same location, these currents moving upward and inward as do the currents about the wire, would produce exactly this result. That each separate impulse or wave has its origin at an equal distance from the wire on all sides accounts for the concentric appearance of the field about the wire as will be seen by Figure 8, where the upward currents are shown passing thru a sheet covered with iron filings. The production of these inward and forward currents about the charged wire, produced by the current in the wire, are in exact accordance with our knowledge of the effect of a moving body, such as a projectile thru the air.

With the direction of these currents in mind, and remembering the spiral nature and direction of the currents surrounding a magnet, see how exactly these accord with the action of a magnetic needle placed in the magnetic field of a wire bearing a current and how clearly and logically it accounts for the action of the needle. When

The author of the present article has, to many minds, opened up an entirely new field of experimentation with his "magnetic currents." Particularly would this appear to be the case in the previous articles in which Mr. Mace showed some excellent photographs taken by what he calls "magnetic currents" and which he produced by placing a magnet close to a covered photographic plate for a period of several weeks in total darkness, when the outlines of several objects lying on the photographic plate were actually photographed thereon.

Many years ago (1851), however, quite similar phenomena to these outlined were observed and explained at great length in a scientific work by Baron Von Reichenbach, who claimed that it was possible to "see" the magnetic force about magnets, and to which the name of "odic flame" was given.

a magnetic needle is placed within the influence of a wire bearing a current of electricity upward, the needle points to the north when on the east side of the wire, to the west when on the north side of the wire, to the south when on the west side of the wire, and to the east when on the south side of the wire. In the first position, to the east of the wire, with its center at the point of tangency of a concentric circle, the currents surrounding the magnet on the side nearest the wire will be moving in the same direction as the currents drawn towards the wire and upward as shown in Figure 9, in which are shown the currents moving upward and toward the wire and on the right, or east, a magnetic needle with its south pole indicated and the currents surrounding it moving in the same direction as the currents moving toward the wire. At the left, or west, of the same figure is a needle with its north pole pointing south showing the currents about it also moving in the same direction as the currents toward the wire. In both cases there are four conditions tending to keep the needle in this position with its center tangent to the circle. The currents on the under and inner side of the magnet will be re-enforced by the currents moving toward the wire and these currents will tend as far as possible to set themselves in parallel directions and these forces acting upon the equidistant ends of the needle will be equal and the needle will be in equilibrium as a tangent with its center touching the circle. The spiral currents emerging from the center of the magnetic needle are strongly drawn into the currents entering the wire and thus the center of the needle becomes the natural center of equilibrium. The currents about the magnet on the lower and inner side are moving in the same direction as the currents entering the wire and a partial *ether-vacuum* is formed and the tendency of the needle is toward the wire but so long as the ends are equidistant the equilibrium is maintained with the needle tangent to the circle. On the upper and outward side of the needle the currents are moving counter to the currents entering the wire and a *condensation* is set up tending to force the needle toward the wire

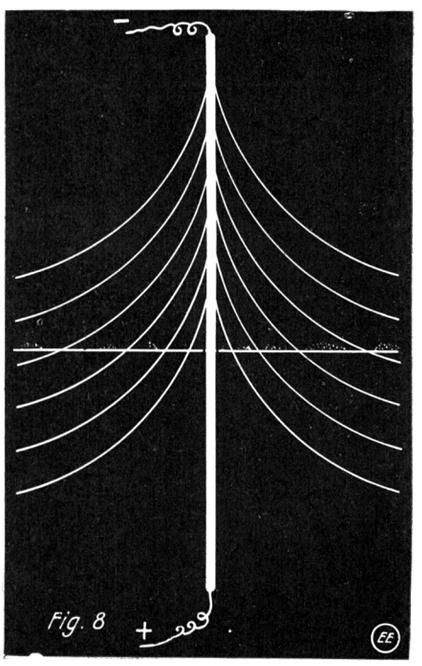
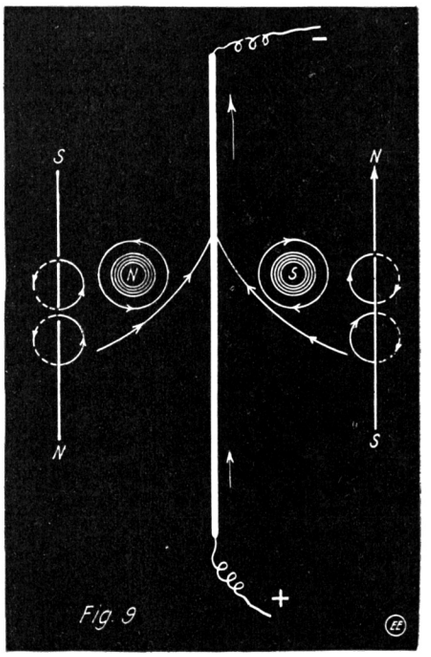


Diagram Showing How the "Wave Motion" About a Charged Wire Produces Concentric Rings of Force on a Plate Containing Iron Filings, By the Upward Movement of the Conductor Currents.

but so long as the ends of the needle are equidistant equilibrium is maintained with the needle tangent to the circle with its center touching the circle. Move the needle



How the Author Explains the Action of a Magnetic Needle (Compass) When Placed in the Field of a Charged Conductor.

on the right 1 mm. directly north. The equilibrium is at once destroyed. The currents tending to re-enforce each other and to move parallel are now acting upon 2 mm. more at the north end of the needle than at the south end. The currents at the center of the needle are further from the point of tangency and the center is drawn toward the wire. The vacuum on the inner side of the needle is acting upon 2 mm. more of the north end of the needle than upon the south end, the condensations on the outer side of the needle are acting upon 2 mm. more of the north end of the needle than on the south end, and the north pole of the needle is deflected to the west until the center of the needle again becomes the point of tangency and equilibrium is restored. The same condition will prevail as the needle is moved along until at the north of the wire the needle will point to the west. Continue, and at the west of the wire the needle will have its north pole pointing south, as shown in the figure. The needle will always set itself tangent to the circle at its center point so that the vacuums and condensations at both ends will be equal, so that the currents surrounding the wire and the magnet will, as far as possible, be moving in parallel directions, and so that the two sets of currents between the wire and the magnet will be moving in the same direction and re-enforce each other. This is in accordance with all known laws of physics—it is what would be predicted of air currents under the same conditions.

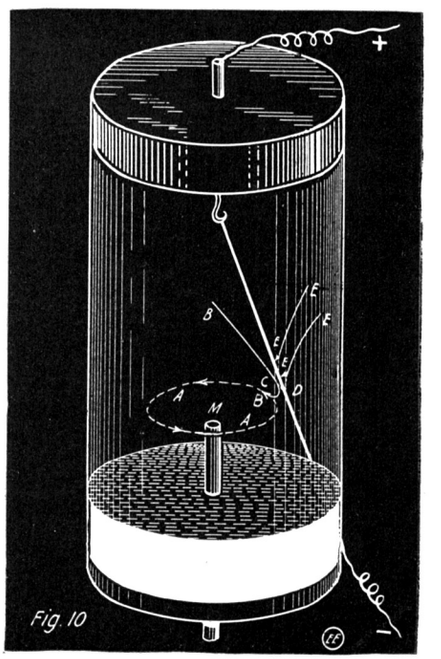
So far we have spoken of this motion about the wire and the magnet merely as "currents." Now let us consider what these currents really are. It has heretofore been considered and conceded by physicists that the "lines of force" in these fields are *ether effects;* that they are "lines of tension," "lines of direction," etc., in ether, and that the waves given off into air by an electric discharge are *ether waves.* A magnet works just as well and just as effectively in a vacuum where ether is the only substance present as it does under other conditions. Finally, the action of these currents on a photographic plate in the production of magneto-graphs by the magnet and the charged wire prove these currents to be *currents of ether.*

Granted, that magnets owe their effects to ether currents about them, and there can be no further question in regard to this, how simple and logical becomes the action of the magnetic needle, the creation of electromagnets, and the phenomena of magnetic attraction and repulsion.

If two solenoids or two permanent magnets be placed one above the other with their north poles pointing in the same direction, the currents on the upper side of one and the currents on the under side of the other will be moving in opposite directions. These currents meeting each other will form condensations, will mutually oppose each other, and the reaction will drive the poles apart. This action will continue till the north pole of one is over the south pole of the other, in which position the currents at both poles of the two magnets on the upper side of one and on the lower side of the other will be moving in the same direction, the currents will re-enforce each other; the tendency will be to set themselves parallel to each other, a partial vacuum will be formed and the poles will be attracted towards each other.

Under these conditions the action of a magnetic needle in pointing to the poles of the earth is no longer mysterious. An average child might be led to see the cause. The earth is rotating in ether from west to east. This, and the revolution of the earth about the sun, sets up ether currents moving from east to west about the earth, just as a ball whirling in air has air currents about it. This, as with the currents about an electromagnet, makes the north pole of the earth a south magnetic pole. A magnetized needle then tends to turn so that its north magnetic pole points to the south magnetic pole of the earth as explained in regard to two magnets, so that the currents about the earth and the currents on the under side of the magnet will

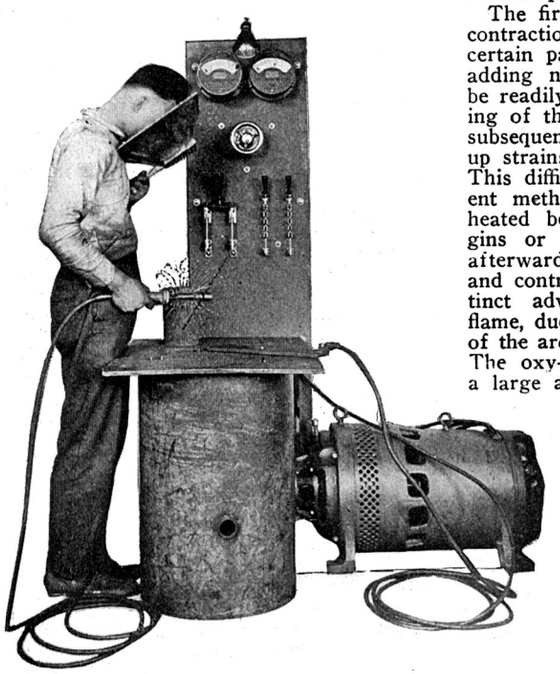
(*Continued on page* 486)



The Well-known Experiment of the Revolving Wire Dipping in Mercury, Is Used to Further Prove the Author's Case of "Currents About Magnets."

WELDING WITH THE ELECTRIC ARC.

Reduced to its simplest terms, the electric arc is a gap in an electric circuit. The current "jumps" or "arcs" across this gap.



Complete Electric Arc Welding Outfit. It May Be Moved From Job to Job When Desired. Note the Glass Shield Which Operative Uses to Protect Eyes From Blinding Glare.

It does this against great resistance because electric current does not pass easily thru the atmosphere. Because of this resistance great heat is produced and the ends of the gap in the circuit become very hot.

Boys have made an electric arc for welding purposes by simply connecting to the leads in a pair of lead pencils each wire of an electric circuit. When the leads are touched and drawn apart an arc is formed and heat is produced which is great enough to melt metals with which it comes in contact. In actual practise this process is of course much refined, as a matter of fact the metal which is to be welded usually forms one end of the gap, or one electrode, and a stick of carbon or a rod of metal forms the other electrode.

The heat produced by the electric arc has never been measured, but it is variously estimated at a temperature of 6.500 to 7,000 degrees Fahrenheit, and is the highest temperature which can be produced at the present time.

The principal advantage of the electric arc for welding is the fact that it produces intense heat at very low cost. Compared for instance with the oxy-acetylene torch, the electric arc will produce effective welding heat at from ten to thirty per cent of the cost of the other method.

The electric arc may be used for welding practically all metals. There are several practical difficulties, however, which are always encountered in welding work. These limit the use of the process for commercial purposes somewhat.

The first difficulty is the expansion and contraction which results from heating a certain part of a piece of metal or from adding new metal in any part. It will be readily seen for instance how the heating of the rim of a metal wheel and the subsequent cooling of that part would set up strains in different parts of the wheel. This difficulty can be overcome by different methods. The whole piece is often heated before the welding operation begins or it may be annealed by heating afterwards. In the matter of expansion and contraction the electric arc has a distinct advantage over the oxy-acetylene flame, due to the fact that the intense heat of the arc is confined to a very small area. The oxy-acetylene flame always heats up a large area around the weld.

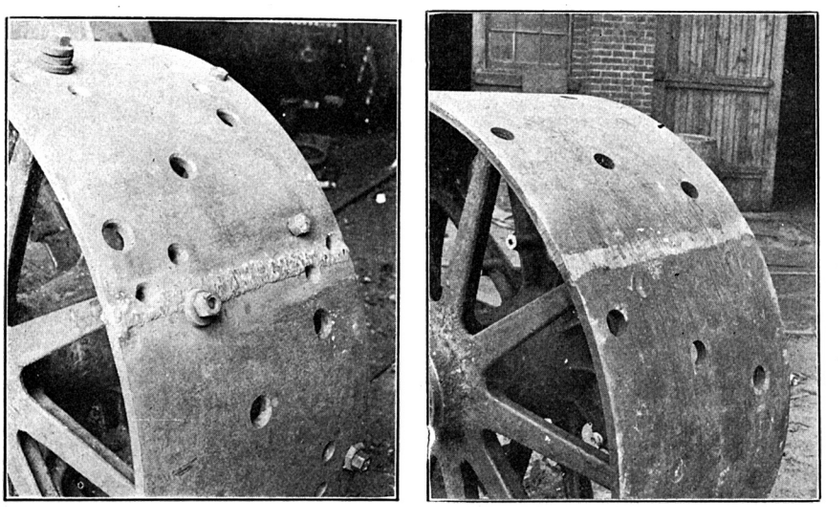
The second difficulty in welding is due to the formation of oxids. Metals at high heat combine with oxygen, the oxids thus formed on the parts of the metal to be welded will prevent the metals coming in intimate contact and a perfect weld cannot result. The welded surfaces, however, may be kept clean by floating the oxid on top of the molten metal.

Let us say that the arc in a given welding example uses 150 amperes current, the voltage of the supply line is 250 volts, and the voltage really necessary at the arc for welding purposes averages 25 volts. Also assume that the current will cost 2 cents per K.W.H.

We will then compare the cost of electric power first, when welding with simply a resistance in the circuit; second, when welding with a 75 volt constant voltage motor-generator, and third, when welding with a 25 volt motor-generator.

We shall then have the above figures.

System	Formula	Current in Arc	Kilowatt hours per hour welding	Cost of Power per hour of welding
250 Volt line with resistance.....	$\frac{\text{Amp.} \times \text{Volts}}{1000}$	150 Amp.	37.5	75 cents
Motor generator, 75 Volts Constant with resistance.....	$\left(\frac{\text{Amp.} \times \text{Volts}}{1000}\right)1.25$	150 Amp.	14.06	28 cents
Motor Generator Variable Voltage, average 25, no resistance.....	$\left(\frac{\text{Amp.} \times \text{Volts}}{1000}\right)1.25$	150 Amp.	4.69	9.4 cents



A Good Example of Welding Rolled Steel. The Rim of this Motor Truck Wheel Is Formed by Rolling a Steel Plate Into Shape, Welding the Two Ends Together. The Illustration Shows It Before and After Finishing. The Metal at the Weld Was Cut Down Until It Was No Greater In Thickness Than That In the Plate and Still It Was Sufficiently Strong for this Severe Service. Finished Rim at Right.

AN ELECTRIC AUTO INDICATOR YOU CAN'T MISS.

A New York inventor has recently patented a novel device for indicating the direction proposed to be taken by moving automobiles.

Two lamp bodies are fastened in the middle of the rear mud guards. Suitable bulbs are connected with storage battery or other existing power source and may be

You Can't Miss this Electric Auto Indicator. The Illuminated Hand at Right or Left Indicates Which Direction the Machine Is Going to Take. Works In Daytime as Well as Night.

illuminated by a mechanism placed on the shaft of the steering wheel or near the driver. When the lamp in either lamp body is lighted, a large figure of a hand is shown up clearly. This figure shows as distinctly in the sunlight as it would at night. The hand points the way the car is going to be steered or driven.

Transparency glasses are furnished in the forward sides of the lamp body and when illuminated the direction in which the car is going to be turned can be seen by a car being driven toward it, as well as any car approaching from the rear.

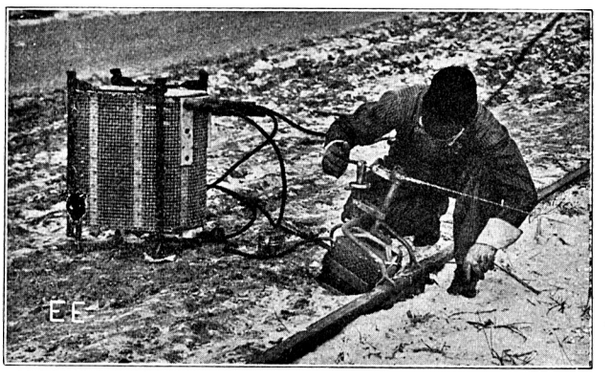
A bell situated at any convenient position on the car is so arranged that it rings at the time bulb lights and continues till the light is turned off.—Allen P. Child.

NEW PHYSICO-CHEMICAL INSTITUTE IN JAPAN.

The "Elektrotechnische Zeitschrift" contains a note on the new physico - chemical research institute being establisht in Japan. It is stated that 2,000,000 yen has been allotted and that the buildings were partially completed by the end of 1916. Among the subjects to be dealt with at the institution are: Electrical and electrochemical researches, testing of instruments and thermometers, research on optical glass, synthesis of colors, rubber and oil, the fixation of atmospheric nitrogen, microscopy of metals, etc. The program also provides for a systematic study of the natural resources of Japan, Korea, Manchuria, etc.

PORTABLE ELECTRIC WELDER BONDS TRACK RAILS.

In order to provide a means of installing electrically-welded bonds, which would be within the economic possibilities of every railway, however small, a Cleveland, Ohio, concern has developed a portable welder. This apparatus is extremely simple, consisting merely of a resistance element, weighing about 200 lbs., and an electric furnace weighing 65 lbs. The function of the apparatus is to make possible the utilization of the current from the trolley for welding the bonds onto the rail with the smallest possible apparatus. By the use of this outfit an electrically welded bond is obtained with a contact having an initial high conductivity, and one which is claimed will not depreciate on account of the elements, etc. In obtaining this union between the bond and the rail, neither an arc nor flame strikes the bond or rail, thus avoiding the danger of injury to the bond, rail and eyes that such methods are liable to introduce. Instead, a heated block of grafite presses against the bond terminal, which produces a true weld and which is accomplisht with neither injury to the operator, the bond or the rail.



Welding Trolley Track Bonds With An Electric Furnace of Special Design. It Works Quickly and Is Portable. Time Per Weld Is About One Minute.

The apparatus is held in position for installing a bond by a yoke which sets over the head of the rail and a chain and hook fastened to the opposite rail. This holds it in a tilted position, so that a part of its weight presses the bond.

The process is as simple as the apparatus. The trolley circuit thru the resistance and furnace to the rail is completed by closing the 200-ampere circuit breaker mounted in the center of the rheostat and controlled from the handle at the bottom. The regulation of the welding is obtained by adjusting the position of the electrode and by the use also of five points on the rheostat for this purpose. A current of from 60 to 125 Amp. is used in making a weld and a separate weld is made for each terminal of the bond. The time required per weld is about one minute.

ELECTROLYTE LEVEL INDICATOR FOR IGNITION BATTERIES.

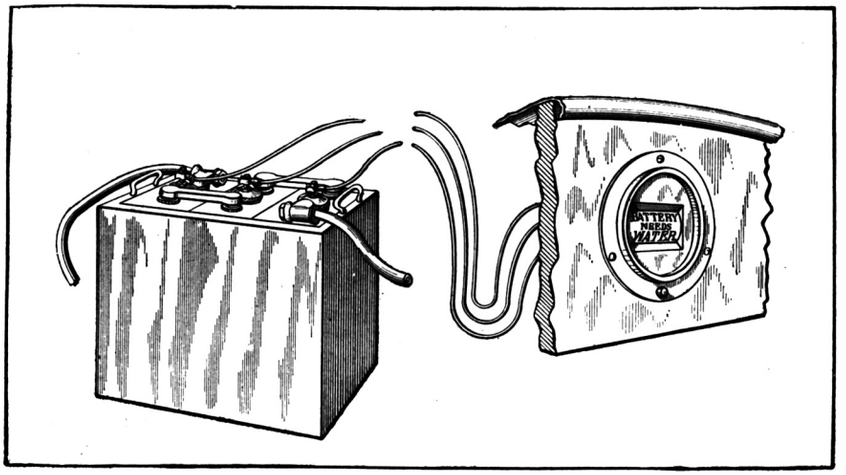
Our illustration shows a new "Battery Protector" gage and its connections to the storage battery of an automobile.

The dial of the instrument shows that the battery needs water which means that the electrolyte in one or more of the jars of the battery has evaporated until the level of the fluid is approaching the low danger point.

When all of the jars of the battery are sufficiently filled with fluid, the instrument will show blank.

Nearly all battery trouble is directly traceable to a condition in which the fluid in the battery has been permitted to evaporate without being replenished, thereby exposing a portion of the plates and resulting in serious danger to the battery.

With this "Battery Protector" installed on your car, you are immediately notified in event the evaporation of the fluid in the battery reduces the level to the danger point and instead of taking the filler cap off the battery every few days to determine whether or not there is sufficient fluid in the jars, you simply watch the gage dial and as soon as the fluid level is lowered (or the battery develops a leak or low cell) you are advised.



Every Battery User, and That Includes Most Every Autoist, Knows What a Nuisance It Is to Keep Tabs on the Electrolyte Level. Here's An Instrument That Indicates Instantly When "Battery Needs Water."

There is absolutely no chance of the device failing to indicate the low fluid level in the battery as the device works on a closed circuit and displays its warning signal as soon as the circuit is opened.

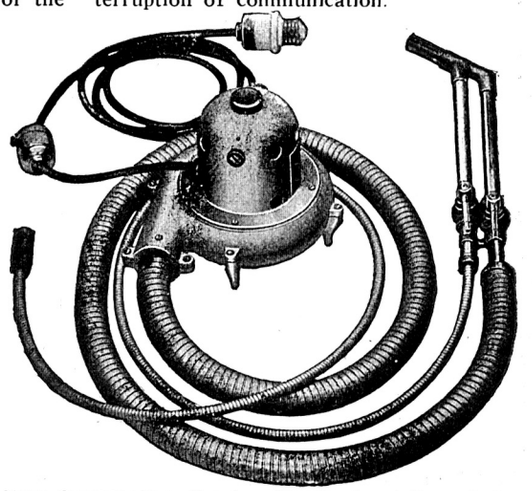
ELECTROLYTIC BEHAVIOR OF TUNGSTEN.

Walter E. Koerner has carried out extensive experiments and research work under the direction of Dr. C. G. Fink, in the research laboratory of the Edison Lamp Works at Harrison, N. J. He recently made public the results of his investigation in a paper read before the American Electrochemical Society. An interesting feature of the paper was that regarding the use of tungsten in cells. In this connection the author states that for the construction of a voltaic cell with tungsten as the negative electrode it is desirable to use an electrolyte in which both the tungsten and the anodic reaction products are most soluble. With a sodium hydroxid solution as electrolyte, mercury or silver may be used as positive electrode against tungsten as negative electrode. The emf. of such a combination using mercury is 0.49 volt, with silver 0.69 volt. Preliminary experiments with tungsten both as fused slugs and as metal powder were promising, especially those with the latter. Another series of experiments was made and is still being continued on the use of tungsten in standard cells, results of which will be announced later.

A NOVEL SELF-CONTAINED ELECTRIC-GAS BRAZING TORCH.

Electrical manufacturers and contractors with small or medium-sized shops where comprest-air equipment is not installed often are at a loss for convenient facilities for brazing small pieces, heating melting pots, annealing and hardening small tools, etc. For these and similar purposes there has been placed on the market the compact combined electric and gas torch here illustrated. The outfit consists of a small motor-driven blower, that furnishes the air blast, a brazing blow pipe, five feet each of armored air hose and gas hose, and a five-foot connecting cord with feed-thru switch and attachment plug. The motor is a universal machine suitable for use on 100-volt direct or alternating-current circuits. The gas supply pipe should be at least one-half-inch size. Using standard illuminating gas with the outfit it is possible to obtain a temperature of 2,300 degrees Fahrenheit, which means that extremely rapid work can be done. The gas and air supply can be readily regulated by means of the cocks in each supply hose. The blower is powerful enough to supply air for four burners.

Woody Island, near the Alaskan town of Kodiak, will be the site of the big radio station the Navy Department is about to establish to connect Alaska with the chain of wireless stations on the Lower Pacific Coast. This will insure against interruption of communication.

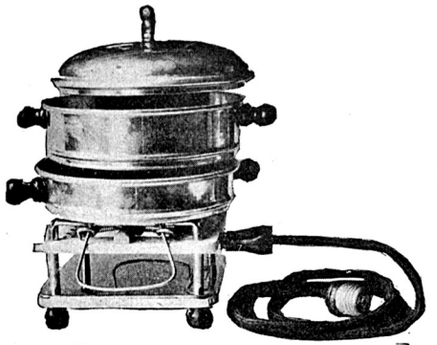


New Combination Brazing Torch, Consisting of Gas Blow Pipe and Electrically Driven Air Blast. It Is Extremely Compact and Needs Only to Be Connected to Gas Pipe and Light Socket.

NEW ELECTRIC STOVE AND STERILIZER.

Perhaps what is one of the more advanced types of electric stoves is now being offered on the market.

A distinct innovation is the structure of



Latest Electric Sterilizer For Dentists, Physicians, Etc., the Electric Heater Being Available Whenever Desired as a Stove or Toaster.

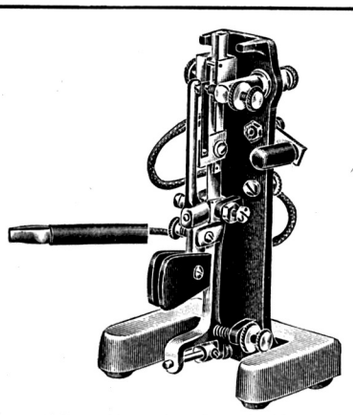
the stove, it being made in a new way, very light, strong and durable. It has all the good points and none of the bad ones. It can cook, broil, toast and do a number of other things as a much needed convenience in the home, and is also adapted to laboratory and sickroom with its sterilizing equipment. With the pans as shown in the photo are furnished racks so that medical instruments, etc., can be placed in the same for thoro sterilizing.

With its number of good features and multifarious service delivered, it should find many friends.

A VERTICAL TELEGRAPH SPEED KEY.

Herewith is shown a new vertical telegraph speed key. The vertical key combines in one stroke extreme simplicity, efficiency, light weight, (one and one-half pounds) and it produces a very superior quality of full, solid, clean-cut dots. In addition may be mentioned the fact that with this new instrument it is next to impossible to run dots and dashes together.

It represents an improved type of single contact instrument and it is so extremely simple that it reduces repairs, adjustments and replacements to a minimum. The key has a remarkably easy touch. Moreover it is unnecessary to change any adjustments about the machine except to slide the speed weight up or down when it is desired to send faster or slower or to adjust the tension springs so that the



Something New in Speed Keys for Radio and Telegraph Operators. It Sets in a Vertical Position, Being Held Upright by a Substantial Base.

"touch" of the key lever feels best. And you can, of course, regulate the lightness or heaviness of dots by turning the contact screw in or out—just a little at a time—until the dots appear to be solid and clear. Otherwise, there are no adjustments to be made.

A REMARKABLE ALUMINUM SOLDER.

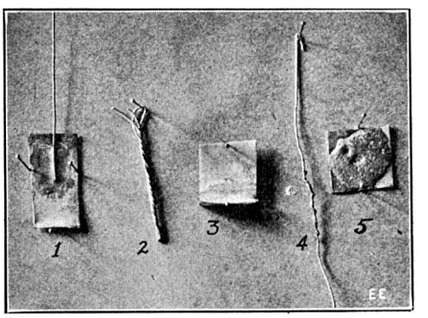
Soldering aluminum parts to one another or to other metals has always proven a very difficult proposition, and this problem has become of extremely vital importance of late owing to the fact that many aeroplane parts are made of this peculiar metal which refuses to unite with any ordinary metal under the usual soldering and brazing conditions, owing to the oxid which forms very quickly on the surface of the aluminum, as soon as it is cleaned preparatory to making a joint.

It remained for Dr. O. F. Reinhold, of New Jersey, to invent a really successful aluminum solder which most important of all, makes a joint which is every bit as strong and generally stronger than the metal itself, which it unites. No flux is necessary with this solder, and it can be melted in the ordinary Bunsen flame.

The accompanying photograph shows several samples of the work which can be done quickly and without the least trouble or preparation of the pieces, and all of which specimens were prepared before the Editors by the inventor.

Specimen No. 1 at the left shows how a piece of aluminum, copper or brass wire can be united to a piece of aluminum sheet so as to form a solid connection, producing in this way an extremely serviceable electrode for use in electrolytic rectifiers or electrolytic chemical determination apparatus.

Specimen No. 2 shows several wires twisted tightly together, but without any cleaning at all and which were firmly soldered in a minute's time with this new



Some Specimens of the Work Accomplisht by New Aluminum Solder. The Joint Is as Strong as the Stock.

aluminum solder, the solder running thru between the wires and making a first class joint in every particular.

Specimen No. 4 is also a wire joint made with this solder. No. 3 shows a small square piece of aluminum sheet soldered to a similar piece at right angles. Not only was this joint very solid, permitting one to bend the aluminum to any degree without showing the least strain at the joint, but once the top wing shown was soldered on and "set," it was then possible to solder another piece on the opposite side of the longitudinal strip without loosening the solder at the first joint—a truly remarkable characteristic of this unique soldering and welding preparation which occupied eighteen years of the inventor's life in its solution.

Figure 5 shows one of the most novel applications of this aluminum solder which one can imagine, viz., that of causing ordinary *wire solder* to flow and securely take hold on a piece of aluminum sheet. The inventor has outlined a possible and very radical idea in this direction with reference to storage battery construction. He proposes that where a light weight storage battery is desired, that the base structure of the plates be made of aluminum and then coated with lead by means of his new solder. The inventor also claims that his solder changes to aluminum itself.

ALL ABOARD FOR THE DECEMBER "E.E."

The Xmas number of THE ELECTRICAL EXPERIMENTER *will fairly teem with good things. It will contain articles of interest to every man, woman and child—to use the language of the "Big Show" barkers. There will be special feature contributions from well-known writers as well as many new ones. If you want to know what to buy or what to make for Xmas, then don't fail to read the "December" issue. Among other feature articles are the following:*

"A New Electric Bomb Dropper For Aeroplanes," by F. R. Lewis, Military Expert.

"Locating Submarines by Radio Waves—A Tested Scheme," by Leon W. Bishop, One of Edison's Electrical Experts.

"The Aurora Borealis; Its Effects on Telegraph and Cable Lines," Some facts on this remarkable phenomenon.

"How to Use High Frequency Currents in the Treatment of Disease," by Dr. Frederick Finch Strong, M.D.

"The Marvels of Radio-Activity,"—Part IV., by Jerome S. Marcus, B.Sc.

"A Revolving Electric Xmas Tree—How to Make It," by John T. Dwyer.

"The Mysterious Voice"—A Clever Home-made Electrical Illusion, by C. A. Oldroyd.

"The Audion vs. the Edison Effect," by George Holmes.

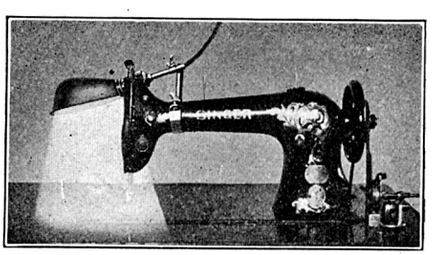
"Radio Transmitting Inductances"—5th paper of "How and Why of Radio Apparatus" Series.

A Funny Electrical Story—"Telling Time by the Stars," by Thomas Reed.

"Experimental Physics"—Lesson 10—by John J. Furia, A.B., M.A.

ELECTRIC LIGHT FOR THE SEWING MACHINE.

The adjustable light fixture here illustrated provides a perfect and directly applied working light. By so doing they increase the efficiency of the operator. By their use all machines can be lighted to save current and to prevent eyesight troubles, the makers state.



Investigation Has Shown That About $40,000,000 Is Lost Annually By all Manufacturers, in the United States, Thru Improper Lighting, and That the Clothing Trades Bear Their Share. Here's One Answer to the Problem.

The lamp can be placed instantly in any desired position or as quickly moved out of the way.

Action at a Distance as Exhibited in Selenium Crystals

By PROFESSOR F. C. BROWN, PH. D.* STATE UNIVERSITY OF IOWA

ACTION at a distance has puzzled physicists and philosophers alike for centuries. By what means can the Sun act on the earth to heat it, or by what mechanism can the Sun act on the earth so as to be constantly

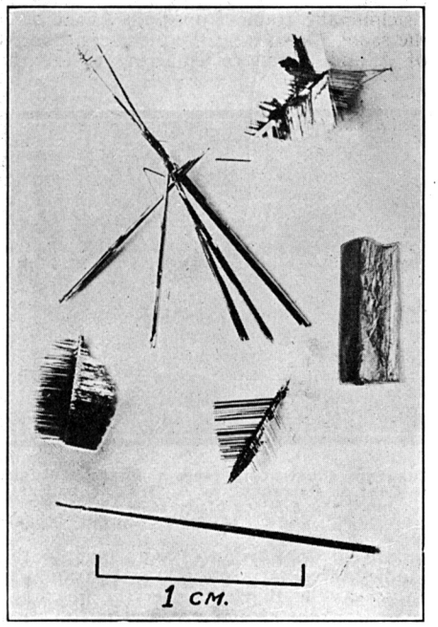
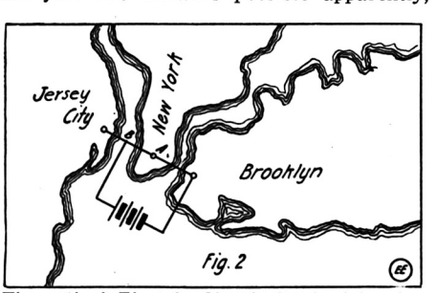


Fig. 1. A Few Specimens of Extra Sensitive Selenium Crystals Used by Professor Brown in His Researches on the Electrical Action Occurring in This Substance.

pulling the latter away from a rectilinear path? Or how can the earth continually accelerate the moon toward the earth? We have had to be satisfied in these latter cases with the knowledge that the mutual attractions between these planes are in accord with the law of gravitation. But no physicist even thinks he knows what gravitation really is. Generally we think that heat on the Sun is a molecular motion, a part of which is transmitted to the earth by consequent waves set up in a hypothetical medium, the *ether*. But grant the necessity of this medium, who knows how these waves are set up by vibrating electrons or molecules! It would be out of place here to discuss all the difficulties that this ether has plunged us into. Primarily this ether was and is required to explain radiation and gravitation at a distance.

How can two charged pith balls which are disconnected, repel each other. There are just two answers possible apparently,



Theoretical Electric Circuit Devised by Author to Show That Changes in Resistance, Etc., of Single Conductor Extension at B Will Not Affect Current in Closed Battery Circuit.

one is that some medium surrounding one ball is set in some state of stress or agitation which reacts on the second pith ball. The other explanation is that the one pith ball acts at a distance when there exists a charged body at the distant point. The action is usually supposed to be transmitted by some method not thoroly understood; something like mental telepathy perhaps. Similarly two magnetic poles act on each other at a distance as will also a current of electricity act on a distant magnet.

Action at a distance in matter is quite a different phenomenon, because it is easy to imagine almost any desired mechanism in matter and because we have become familiar with certain transmitted effects in matter. Thus an earthquake may effect a seismograph on the opposite side of the earth, by a wave sent thru or around the earth crust. A bar of iron if heated at one end will, after a time, become hot at a distant point, by the well known process of conduction thru molecular motion. If a copper wire is supplied with an excess of electrons at one end or merely acted on by electromagnetic forces, there will be manifest certain electrical changes at the opposite end.

But in the instances above the transmission is relatively slow compared with light and gravity. There is manifest in selenium crystals an action that seems to be transmitted much more rapidly than other actions in matter mentioned above. Some of these selenium crystals are reproduced in Fig. 1.

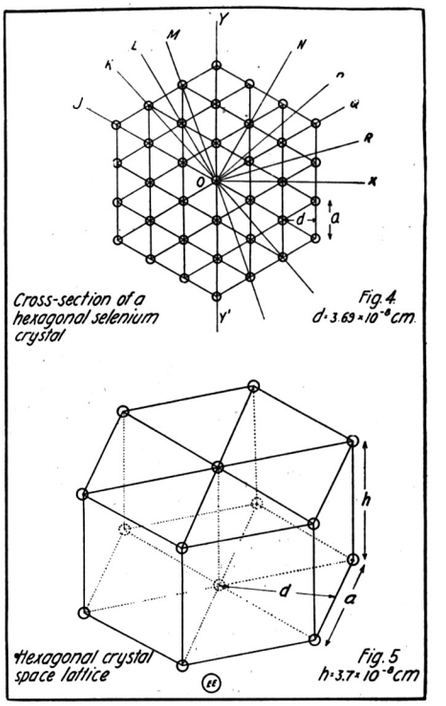
Imagine an electric circuit connecting New York and Brooklyn with one wire forming a part of the circuit projecting into Jersey City as shown in Fig. 2.

Now it is perfectly well understood that if the physical conditions surrounding the wire between the points A and B are altered, the resistance and consequently the current may be altered, *e.g.*, if the temperature rises in the region AB the resistance will rise. But the part of the wire projecting out into Jersey City, no matter how much it might be heated, would exhibit no change of resistance, beyond the region AB.

Now if we imagine the wire projecting thru AB to be replaced by a metallic selenium crystal of the hexagonal system, we have an entirely new situation. Consider the circuit shown in Fig. 2 or Fig. 3. A selenium crystal whose length is about 100 times its diameter, has one end clamped between electrodes in such a manner that the electric circuit is completed. Now if a narrow pencil of light falls on the part of the crystal between the electrodes, the conductivity of the crystal is altered; most of the change taking place within .01 second. This has been known for some time. However, if the same pencil of light falls anywhere along the crystal, the change of conductivity between the electrodes is almost as great as if the light impinged there. Moreover the change of conductivity takes place just as rapidly when the illumination is at one end of the crystal as at the other, so far as measurement can determine. In other words the action of light on the crystal at O is transmitted to P without any apparent lapse of time. At least the lapse of time is less than .01 second. The conductivity itself takes place only between the electrodes and not around the crystal as is proved by the fact that no alteration of the conductivity occurs by breaking off the crystal at any point beyond the electrode contacts. The fact that the transmission of the light action takes place in less than one hundredth part of a second, is ample proof that the transmission is not of the nature of a heat wave.

A New Property in Matter

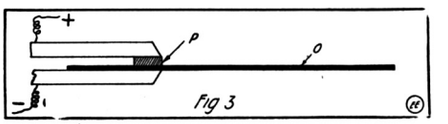
Thus we have found a new property in matter, *viz.*, the illumination of matter at one point and consequent action taking place at a distant point. The magnitude of the distance is probably limited only by the length of the crystal. Thus far this limita-



X-Ray Analysis Has Shown That the Selenium Atoms Are Situated at the Corners of Triangles, in Such a Manner as to Form Hexagons. The Distance Between Atomic Centers Is of Course Extremely Small.

tion has been about 15 millimeters. The manner of transmission is just about as much a mystery as the transmission of the force action between the Sun and Earth.

An X-ray analysis shows the selenium atoms to be placed at the corners of triangles in such a manner as to form hexagons. The distance between the atomic centers as shown in Fig. 4 is 3.69×10^{-8} cm, when measured perpendicular to a regular surface running parallel to the principal axis. These hexagonal plates are fitted one against the other lengthwise so as to build up an acicular hexagonal crystal such as shown in Fig. 5. The distance between these plates as shown by the X-ray spectrum is 3.7×10^{-8} cm. or .037 millionths of a centimeter. From this data and the knowledge of the density and atomic weight of selenium crystals, it is very easy to



If a Narrow Pencil of Light Falls on a Selenium Crystal at O, It Acts in the Same Space of Time as If the Light Acted on the Point P. Truly, Action at a Distance.

show that two atoms of selenium are placed at every point in the space lattice composing the crystal.

The light might produce a vibration of the selenium molecules or the planes of molecules and then these planes of molecules would produce motion in the next neighboring planes and so on until the planes all along the crystal were in vibration. In this case the vibration would be

(*Continued on page* 489)

* Paper specially written for THE ELECTRICAL EXPERIMENTER.

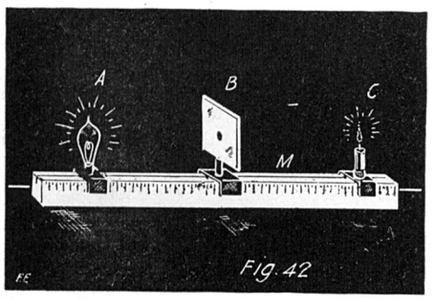
Experimental Physics

By
JOHN J. FURIA, A. B., M. A. (Columbia University)

LESSON 9.

Light (Continued).

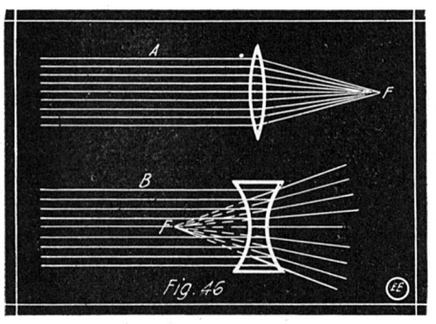
THE second and more important difficulty in the way of the *Wave Theory* of light was that it failed to account for the fact that light is propagated in a straight line. Sound, water, and all other forms of waves with which we are acquainted bend around corners, whereas light does not. The German Band's melodious (?) strains (on the ear) are readily heard from around the corner, but the players cannot be seen, because of this fact. During the last century, however, this difficulty has been removed completely, and it has been found that light has other properties which can be satisfactorily explained by the wave theory and not by any past theory.



A Simple Apparatus for Measuring the Candlepower of an Incandescent Lamp Is Readily Constructed as Shown.

In the preceding lesson it was indicated that if the Wave Theory is to be accepted, we must hold the same view as Huygens, namely that *all space is filled with a medium called the ETHER,* in which these light waves travel. This medium is altogether different from the ordinary forms of matter, for if any of the ordinary forms of matter permeated interplanetary space, the motion of the planets and other heavenly bodies would be retarded, while as a matter of fact no such retardation has been observed by the astronomers during these many centuries, despite the extremely accurate observations that have been made. Hence our ETHER has a density infinitely small even in comparison with such light gases as Hydrogen. The existence of ether is now practically universally assumed by scientists thruout the entire world.

It should be noted at this point that *wireless waves* are also waves of the ether and resemble light waves in many respects. (This will be taken up in detail in a later lesson.)

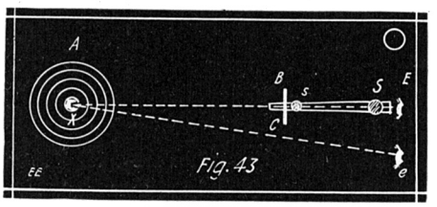


How Light Passes Thru a Convex Lens (A) and a Concave Lens (B). The Point "F" Is Called the Focal Point.

EXPERIMENT 51—

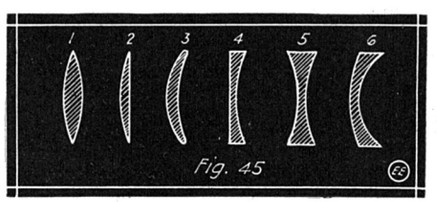
INTENSITY (Brightness) OF LIGHT —Place four candles in a straight line behind an upright pencil, and catch the shadow of the pencil on a white piece of cardboard or other screen. The room should be well darkened. Place one candle up closer to the pencil and not in the line of the four, thus catching another shadow on the screen. If now the one candle is moved, a position will be found when the two shadows are equally dark. Hence the illumination produced at the screen by the one candle and by the four candles is the same. If now the distances are measured from the screen to the candles it will be found that the four candles are twice as far from the screen as the one candle.

This is experimental proof that the **intensity of light varies inversely as the square of the distance,** *i. e.,* the nearer the source of light the greater the intensity or brightness of the light, and greater as the square of the distance, so considerable brightness is gained by even a small distance approach to the source. Intensities of light are usually given in terms of candle-power, one candle-power being defined as the amount of light emitted by a sperm candle 7/8 inch in diameter and burning 120 grains per hour.



How the Sharpshooter Hits the Bull's-Eye Every Time, Even Tho He Places a Piece of Cardboard Over the Front Gun Sight.

An apparatus for measuring the candle-power of an incandescent lamp or other light can be easily constructed and used. M (Fig. 42) is a meter stick or yard stick.



The Various Kinds of Lenses In General Use.

A is the light of which the candle-power is to be found. C is a standard 7/8 inch sperm candle, while B is a small frame having a piece of white paper in it, the center of the paper being spotted with oil or grease. A, B, and C are mounted on small blocks having grooves just large enough so that they will fit the meter stick and slide along it freely. Place C near B, light the candle but not A. If now we look at screen B from the side of C the oil spot appears dark, while if we look at B from the side A the spot appears lighter than the surrounding paper. WHEN THE PAPER IS LOOKED AT FROM THE SIDE OF GREATER ILLUMINATION THE OILED SPOT APPEARS DARK, but when looked at from the side of lesser illumination it appears *light.* Obviously if both sides are equally bright, the spot appears equally bright with the rest of the paper. Hence if A and C are both lighted and moved back and forth until the spot cannot be distinguished from the rest of the paper we know that the illumination reaching the frame from both A and C is the same. Measuring the distances from B of A and C and remembering to use the

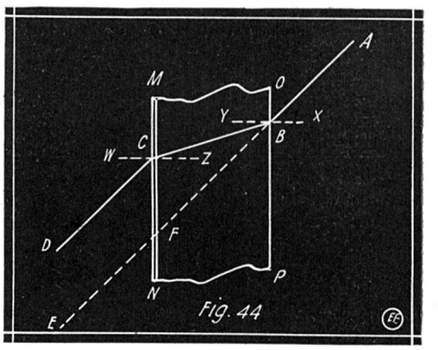


Diagram Illustrating How a Beam of Light Is Bent or Refracted, as A, B, C, D, in Passing Thru a Piece of Glass M, N, O, P.

square of the distances we compute the candle-power of A. This apparatus is known as the Bunsen (after the inventor) or *grease-spot photometer,* and is still used commercially.

EXPERIMENT 52—

Several years ago I saw a sharpshooter give an exhibition of excellent shooting. At the close of the exhibition he performed a seemingly marvelous feat. He shot at his target and hit the bull's-eye while he had a piece of paper stuck over the front sight, which apparently was, as he said, the equivalent of shooting with his eyes shut, (since he could not see thru the cardboard). A careful study of Figure 43 will expose his trick. A is the target, BC the cardboard stuck over the barrel in front of the front sight "s," S is the rear sight, E and "e" are the performer's eyes. With the eye E, the performer sights along S and "s," and sight "s" appears on a certain definite spot in cardboard BC. With eye "e" shut, no matter in what position the gun is held, "s" always appears on the same spot and hence nothing could be hit by the performer except by chance. However, the performer contrary to usual custom in shooting *also holds the other eye open.* Hence thru eye "e" he sees the target, provided BC is just small enough so that the straight line "e"-X

(*Continued on page* 490)

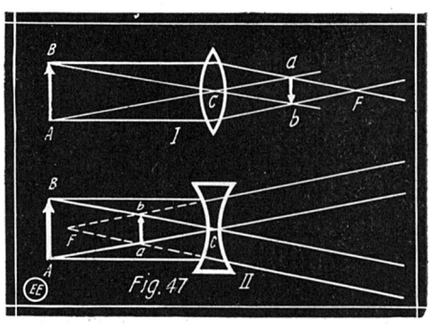


Diagram Illustrating the Factors Entering Into the Determination of the "Focal Length" of Convex and Concave Lenses.

The RADIO LEAGUE of AMERICA

HONORARY MEMBERS
CAPT. W.H.G. BULLARD, U.S.N. NIKOLA TESLA.
PROF. REGINALD FESSENDEN. DR. LEE DE FOREST.

H. Gernsback, Manager W. H. Kirwan, Master of Radio Relays

How Radio Amateurs Can Do Their Bit

By COMMANDER D. W. TODD, U. S. N.
Director Naval Communications and Chief Cable Censor

RECENTLY the Editor of THE ELECTRICAL EXPERIMENTER *asked me for a statement as to how the Amateur Radio Operators of the country can be of most service during the present war. I am very glad to answer this question, and I hope that this matter will reach the attention of a very large number of Amateurs.*

The Navy is greatly in need of radio operators for sea duty, and every opportunity will be given the amateur to serve his country. There was probably never a time in the history of AMATEUR WIRELESS *when it was so easy for a boy to obtain an unlimited amount of training and of practical experience without spending a cent for it. In fact, it is not necessary for a boy to have the slightest knowledge of wireless telegraphy; all that is needed is a desire to learn and a willingness to serve his country in time of need.*

The Navy, which for a number of years has been known as a vast school in itself, has taken special pains to provide adequate facilities for training radio men. Thru the kindness and patriotism of the authorities at Harvard University, the Navy has establisht a Naval Radio School at Harvard, which is now able to take care of 1,500 *pupils. The course is of four months' duration and embraces* MILITARY DRILL AS WELL AS RADIOTELEGRAPHY AND ALLIED SUBJECTS.

However, men are not sent to Harvard until they have reached an operating speed of ten words per minute in the Continental code. This need not discourage those who are interested, for preliminary training is given at no less than nine schools, located at the various Navy Yards. At these schools men are started in from the very beginning and prepared for the course at Harvard.

It is a very simple matter to obtain this free education. There are two ways in which it can be done; men can enlist in the regular Navy or enroll in the Naval Reserve Force. The difference is that enlistments in the regular Navy are for a period of four years of active service; in the Naval Reserve Force, enrollments are also for four years, but the active service is only for the period of the war or such longer time as the President may see necessary; in time of peace, men can resign whenever they desire. In time of peace in the regular Navy, it is possible to secure a furlough without pay for the rest of an enlistment when a man does not desire to serve the whole enlistment. Applicants must be 18 *years old, or if only* 17, *must have the written consent of parents. They must also be able to pass the required physical examination; however, minor physical defects are often waived.*

As indicated above, there is every opportunity for the older amateurs to get a valuable education free, but we must consider those who are not of the proper age or for other reasons find it absolutely impossible to enter the Naval Service. The question is often asked as to how they can be of service, too. There is no doubt in the world that they can be most useful by taking up LAND-LINE TELEGRAPHY.

It is a surprising fact that very few amateur radio operators are familiar with the American Morse code, yet this knowledge is quite essential in many ways. It is one of the requisites for a Commercial Extra First Grade license, for instance. All Navy operators assigned to shore duty must know both codes, for all shore stations have LAND-LINE CONNECTIONS. *It is not to be denied that it means hard work to learn the other code, even after being familiar with the Continental, but anything that is really worth while requires hard work, and since it is quite out of the question to authorize amateur radio stations, spare time during the war may very profitably be utilized thus.*

Any increase in the supply of Morse operators will be of great importance to the country from a military point of view. Every operator not eligible for military duty who secures a position with a commercial company may be the means of releasing a man for duty with our Navy or Army. Both the Western Union and Postal Company are glad to get operators, at salaries ranging from $60 *to* $100 *per month. Women are gladly taken by these commercial companies, if they are competent operators, while they are not eligible for sea duty in the Navy.*

Any amateur who desires further information should present himself at the nearest Navy Recruiting Office, where all features of the service will be carefully explained; any doubtful points should be referred to Commander D. W. Todd, U.S.N., Director Naval Communications, Southern Building, Washington, D. C.

An Interesting, Patriotic Appeal from Stuart W. Pierson, U. S. N., An Old Radio Amateur

U. S. Naval Radio School, Harvard University, Cambridge, Mass.
September 16, 1917.

The Radio League of America,
233 Fulton St., New York City.

Dear Sirs—Noting in the October issue of the ELECTRICAL EXPERIMENTER *the call for radio amateurs to offer their services to the government, I thought it might be of interest to know what I, as a member of the R. L. O. A., think of the Navy after two months of service in same.*

I joined the League shortly after its organization (in 1914) *and offered my services on the application blank. In March of this year I was notified by the Communication Superintendent of the Great Lakes district that I was wanted for the Naval Reserve. Later I enrolled in the same, but was not called at once, so joined the regular Navy and immediately went on active duty. Spent about three weeks at Brooklyn navy yard and was then transferred here to the new Naval Radio School at Harvard University. Outside of the good pay I am receiving and the satisfaction of knowing I am doing my duty, I am acquiring valuable assets that come thru Naval discipline. Of course it is a little hard at first, but as Mr. Herr of the Westinghouse Co., says in the October* ELECTRICAL EXPERIMENTER, *education alone will not insure success. One must have the necessary qualities of courage, tenacity, grit, and the ability to take reverses and hardships cheerfully. These qualities are developed to great extent in the Navy and at the conclusion of the war the Navy man will be prepared to take up his education where he left off with new vigor and he will have the stuff to make good. Of course those who wish to remain in service will also have ample opportunities to get a permanent, good paying position. From almost any angle one cannot fail to see the benefits to be received by joining the Navy. The Navy will be the biggest factor toward bringing the conflict to an end thru the reduction of the efficiency of submarine warfare. As the wireless operator is indispensable to the Navy it is up to the amateur to fill the need. Wishing the League the best of success in its campaign for radio men for the government, I remain,*

Very respectfully,

STUART W. PIERSON, U.S.N.
Formerly opr. of 9PY.

(Continued on next page)

Radio Roll of Honor

AS promised in our October issue, we are publishing in this issue the names of American Radio Amateurs who have voluntarily come forward in offering their services as radio operators to our Government.

Up to the time of going to press (Sept. 25), 425 applications were received, all of which are publisht in this issue. A fair showing for the first month, but very unsatisfactory as a whole. We want thousands more, and the Government needs these names at once. Amateurs of America! Again we say, come forward. Show your good will and your patriotism. After the war is over, YOU will be humiliated when your friends ask you: *"Why was your name not printed in the Radio Roll of Honor?"*

Yes, we ask you, WHY NOT?

Remember signing the blank appended at the end of this article does not send you into the trenches. Indeed, you may never be called at all for service, but the Government ought by all means to have your name on file in case your services should be urgently required. Read the letter by Commander Todd, U. S. N., publisht above, then read the letter of Stuart W. Pierson, U. S. N.—an old amateur;—this young man is in actual service now and as you may judge for yourself, he likes the work immensely.

Now amateurs, let's get busy, let's show the world, that American Amateur Wireless is a great institution, unparalleled and unmatched in any country. What do you say, fellows?

H Gernsback

Radio Roll of Honor

Editor's Note. For obvious reasons, the city addresses of the applicants listed below have been left out. Only the name of the Radio Amateur as well as the State in which he resides have been publisht. Every applicant listed in these columns has pledged his services to his country as a radio operator.

All honor, and our sincere congratulations to every young man whose name appears here.

Alabama
Jas. M. Crump

Alaska
Verne Elliott

Arizona
Irwin Harrison
Fred Roebuck

Arkansas
R. N. Turner

California
Paul Nesbit
B. Ludlow
Harold Jaynes
W. E. Maguire
Robt. Johnston, Jr.
Albert Kober
Ralph Parker
F. Spiekerman
R. Stamback
C. Leslie Stebbins
Jack Hyams
S. Kerckhoff
Robert Kroman
Eldredge D. Barrett
Albert Lauretsen
Jos. Meyer

Colorado
Alison Kurth
Andrew Berglin
H. G. Eyth

Connecticut
Henn Kulikowsk
John T. Biot
C. D. Ryder
Geo. E. Hoke
N. V. Bradshaw
Thos. W. Cumming
Dan Latham
C. G. Hallstrom
Arthur A. Johnson
T. E. Johnson
F. W. Abbott

Delaware
Raymond Phillips

District of Columbia
A. L. Blakeslee, Jr.
J. C. Conner

Florida
E. J. Mazurewicz
T. H. Moore, Jr.

Georgia
A. W. Church
George Wilby
Hugh Schliestett

Idaho
Charles Cherington

Illinois
Joe Aiken
James T. Murray
John Ralph Watkins
D. E. Peebles
Owen Jarboe
J. D. Kingsley
H. R Ferguson
Eugene E. Amory
W. G. Asmus
G. Waldo Ball
R. J. Beuerman
R. W. Bowen
Morrill C. Des Isles
Eugene Ericson
Louis Flader, Jr.
Arthur U. Gardner
Wesley Harmeyer
D. V. Johnson
Chas. J. Keenan
Arthur Larson
Fred C. Leemann
Michael M. Ostropol
William E. Preece
Alex. Sieber
H. E. Smith
J. P. Smarski
Henry Williams
Harold Newman
Chas. F. Enz
Geo. E. Burritt
Frank L. Brittin

Indiana
Roland J. Brown
M. B. Lowe
Wilbur Conrad
M. J. McKee
H. S. Ogden
Howard Moore
Robert Throckmorton
Fred L. Wehr

Iowa
A. V. Molyneux, Jr.
A. S. Osgood
Guy L. Beech
Oscar J. Kost
Virgil Elliott
Joe Aiken
A. S. Bolen
H. W. Evens
H. L. Phillips
Donald A. Laird
Tyle W. Barthel
Huffman Healy
A. B. Church

Kansas
Ernest C. Brown
Russell Mannel
Wm. H. Ritter

Kentucky
John Allen Evans
Elby Becker
B. Wagner

Louisiana.
Walter C. Leahy

Maine
C. M. Sinnett, Jr.
W. Q. Rittall
Harold La Bree
Harold F. Cates
Francis H. Sleeper
J. M. Stanley, Jr.
Richard Saunders

Maryland
M. Biser
J. A. Trabrandt
Fred L. Wehr

Massachusetts
B. M. Spencer
Randolph G. Webber
J. W. Buswell
Wm. E. Blake
Frank Canney
Gordon G. Goodwin
O. G. Lohnes
Chas. McAuley
S. U. Marie
J. H. Nixon
F. J. Rumford
Rolland Adair Gould
Chester L. Keene
Ernest R. Hood
Geo. A. Sweet, Jr.
Geo. E. Varnum
James Cashman
Wallace Hune
Richard A. Stearns
Crocker Mann
David Merriam
John T. Corcoran
Manuel L. Goularte
Leo E. Wüta
Frank Danforth
O. M. Black
F. E. Bern
Francis Durant
Donald Scott
Wm. L. Delaney
M. Mac Leod
H. L. Sawyer

Michigan
Leon Hansen
C. D. Rickel

AMATEURS!
IS
YOUR
NAME HERE?

N. Schlaack
Wm. H. Kibbe
Wm. Forbey
David M. Goodman
Roy Flint
Earle Moyer
Sam Blumenthal
Harold L. Fleming
Ole B. Ritchey
Harry H. Lee
Fred B. Daniels
W. Knowles

Minnesota
Arthur W. Stevenson
Robert Ramage

Missouri
E. D. Muhleman
Lester L. Sanks
Carl Menke
J. Y. Parsons, Jr.
P. Polson
Fred Schillig
Harry Longmire
Cyrus R. Truitt
A. Eppenauer

Montana
Roland Ward

Nebraska
Gordon S. McKenzie
Joe W. Havlicek
H. Havlik
Donald Burdick
Douglas Binghardt

New Jersey
Thomas W. Braidwood
Chas J. Monroe
L. N. Houbroyd
D. B. Templeton
Russell W. Finger
Theo. Chamberlain
Stephen Jussel
S. F. Warner
H. P. Lang
Edwin Lentz
Fred F. Dennis
George F. Harrington
Joseph O. L. Higmegee
Daniel J. Corin
Wm. A. Floyd, Jr.
W. E. Cranston, Jr.
Howard Bering
H. A. Enderwoods
Elmer C. Diehl
Milton Heizmann
W. G. Hunt
Alfred C. Mills
Alfred C. Oechler
Clarence Rossnagel
Joseph F. Grece
Clarence A. Taylor
Geo. Thomas
Fred Walch
Edwin Herrmann
Maxted Clinch
Chas. Hampton
L. & L. Turner, Jr.
F. Franklin

New Mexico
Jos. S. Rhodes, Jr.

New York
Warner G. Palmer
Don Baxter
F. Van Duzer
Earl Paddock, Jr.
Carleton Brewster, Jr.
Robert Anders, Jr.
G. M. Babcock
Geo. D. Burns
T. D. Callan
J. Carlsen
Ed. B. Dyer
Chas Falco
Geo. M. Ferguson
E. G. Gehret
R. C. Gillies
W. E. Haeussler, Jr.
H. C. Hoehle
F. C. Krummel
Albert O. Leitch
Arthur Lowe
Harold McLea
P. Neyland
John E. O'Brien
H. L. Osterby
Peter Pappas
Clifford R. Paul
Jos. Peterson
J. E. Adams
Chas. Ramsgate
James T. Ruddy
Harold Sorensen
John Timmons
Prentice Warren
M. F. Bohneberg
John Quinn
Orimel W. Saxton
C. Benjamin
Paul Widmer
Conway Sheevin
Clarence J. Roberts
James Welch
D. B. McKinney
R. H. Collignon
Ernest Hemann
Walter S. Strong
Sam'l Christie
Leonard J. Edick
R. A. Clapp
Howard A. Crowe
George Grant Felt
W. L. Miller
George Miller
Earl H. Ivanson
Clifford McDonald
Lester C. Palmer
Frank Russell
Fred. A. Shelley
R. Anderson
J. H. Appel, Jr.
Theodore J. Berger
David Carruthers
James Caulfield
Arnold Conard
M. Conroy
Monte Cohen
Clifford Cox
Arthur Davidson
A. Saenz de Calahorra
Harold H. De Palma
C. F. Doebler
Alan C. Dunn
Alex. Elkin
C. B. Embler
Alfred Farago
Wm. Glameyer, Jr.
A. A. Goldon
Alfred H. Hausrath, Jr.
Chas. Hettenbach, Jr.
F. E. Hubbard, Jr.
Donald B. Jackson
Fred. Katz
H. D. Kauffmann

North Carolina
H. E. Norwood
G. T. Finger
O. C. Pate
B. W. Laws

North Dakota
Harry Holmberg
A. R. McKenzie
C. Crawford

Ohio
Harold H. Foltz
Ralph Frase
J. W. Mintz
Jack Gritton
C. B. Wilke
Walter Kottmeier
Jerry John Manning
Louie Mansfield
L. H. Reiner
Donice Hinton
Wm. G. Finch
Carl P. Goetz, Jr.
J. F. Riehle
Ed. K. Ackerman
Russell G. Anderson
Marvin Bower
Harry Bubb
E. A. Call
Louis Charnicky
Fred. D. Frey
John Garse
Robt. Gottschatt
Richard Koenig
Jack Patterson
Ladiman Stasting
P. C. Helwig
Wm. F. Justus
J. E. Purcell
F. M. Reeves
Gilbert Vogel
Loren Wilcox
Elmer Wright
P. S. Gregory
H. W. Jones
W. Bernard Merrick
Bert Osborne
Stephen Spitler
C. J. Linxweiler
Lloyd Rider
Carl Eberhart
Paul Loub
Wendell Ashcroft
J. L. Leppert
Ned Eachus
John Frazier
C. M. Osmbaugh
Miles Bruning
George S. Yerigan
Wm. F. Ball
Chas. Frank
J. B. Stewart

Oklahoma
Donovan Tool
Varnahale Jones
Warren C. Clark

Oregon
Alfred J. French
Morris Knapp
A. D. Rimyard
Arthur E. Gibbs

Pennsylvania
J. S. Bernhard
Blair Cunningham
Roger B. Hernandez
Wm. J. Kreis
J. A. Welle, Jr.
Jno. P. Cunningham
Wm. S. Schmidt
Robt. McKee
Paul Elliott Fischler
Stanley Phillips
J. L. Kirk
Marvin Madden
Otto Von Kories
H. J. Cramer
Chas. J. Mehing
Sam'l S. Szeinbach
Wm. S. Louchheim
Ernest Walker
Daniel Jones
R. W. Hornung
A. L. Rockefeller
R. Ellis Jinkins
H. N. F. Craige
John H. Weikel
Wilbur J. Murdock
E. L. Petit
F. H. Riordan
Geo. M. Albright
H. G. Brantigane
Leroy Mickay
B. J. Bisciotti

Rhode Island
Ed. B. Davis
Earl C. King
Lewis J. Boss
Thomas S. Healy
Kenneth Hiorus

South Dakota
Howard van Benthuysen

Tennessee
Conrad E. Roberts
Geo. O'Neil Sutton

Texas
W. H. Tilley
Edgar Crampton
L. B. Dobbs, Jr.
James L. Autry, Jr.

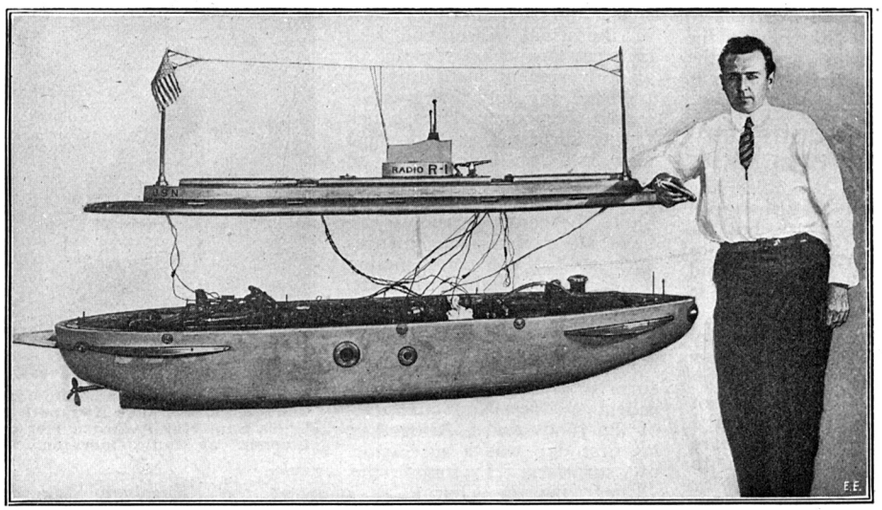
(*Continued on page* 500)

New Radio Submarine to Foil U-Boats

THE illustration shows a new submarine controlled by wireless which may rout the Teuton U-boats. It is Robert Morton's model of a wonderful radio diver invented in his Los Angeles laboratory.

Recently Mr. Morton, using an 800 pound model of his invention, held an audience spellbound while he demonstrated it in a huge tank. The model swam the length of the tank as Mr. Morton touched the key of the wireless transmitter. Another touch reversed the propellers and the model returned to its base. Then an ether wave opened the valves of the little craft and it sank until only its antennae were showing. A tiny torpedo attached to the bow was then released by wireless and sped to the end of the tank.

"I can make a fifty foot submarine on these lines," the inventor said, "fill it half full of nitroglycerin, guide it into the Kiel Canal from an aeroplane and destroy every ship within a mile, or it can be guided into the mine fields of Helgoland, blow it up and sweep the entrance to the German base clear of mines. It simply means using the submarine as a huge mine."



One of the Latest and Most Promising Models of a Radio-Controlled Submarine, With Which Its Inventor Hopes to Blast His Way Thru German Mine Fields to Their Naval Base Itself.

[*Those interested in radio-controlled vessels should read the article in the October issue, page 390, entitled—"A Radio Controlled Model Boat," by H. C. Van Benthuysen and Max I. Black.—Editor.*]

WIRELESS LOG OF A SEA CRIME.

A succession of wireless calls telling the story of a sea tragedy, in which an unknown steamship was the victim of a German submarine, are recorded in the log of a neutral vessel which arrived "in an Atlantic port" recently from a "Scandinavian port."

The calls were recorded while the neutral vessel was passing close to the Irish coast, on her way to this port, and begin with the international "S O S," followed by the message:

"We are being chased by a submarine."

Ten minutes later, the log shows, the following was heard: "Hurry assistance; we are being shelled."

A lapse of 15 minutes followed, then the entry: "Ship is on fire and sinking; captain ordered men to lifeboats."

Five minutes later comes the final message thru the air: "We are done for," giving also the position of the ship.

The neutral vessel, forbidden by regulations to go to the rescue, relayed the call and in about 20 minutes picked up a radio from an American destroyer, reading: "We will reach you in one hour."

PERSONNEL OF A RADIO SIGNAL COMPANY.

A radio company of the Signal Reserve Corps is commanded by a captain and is composed of the following personnel: A captain and two first lieutenants, mounted.

The enlisted men are a master signal electrician, technical expert of the radio company, in charge of making repairs and adjustments to wireless telegraph apparatus.

Six sergeants, first class; one assists the captain, handling questions of supplies, finances, etc., and five radio operators acting as leaders of the five sections of the company.

Nine sergeants—a supply sergeant, a stable sergeant, a mess sergeant, one engineer for the gas engines and five acting as first assistants to section leaders.

Fifteen corporals, one farrier, one saddler, one company clerk (office work), two mechanics (miscellaneous repair work) and ten operators assigned to sections.

Thirty-five privates, first class; two trumpeters, two drivers and thirty-one privates assigned to sections. Six privates, one horseshoer and two cooks.

All are mounted except one mess sergeant, two mechanics and two drivers. The arms carried are automatic pistols.

WOMEN MAY ENTER THE WIRELESS SERVICE.

Women are entitled to the study of wireless telegraphy, the same as men, in the class organized by Prof. Harvey Anthony of the Muncie, Ind., high school, and it is hoped that many will file their applications.

A communication received recently by Prof. Anthony from the war department urges that more women be enlisted in the service. The letter reads that women telegraphers are in demand by the government for both the army and navy. They will not be taken abroad however. Their assignments will be at shore stations.

MANY STUDENTS TAKE U. S. WIRELESS COURSE.

Many students are taking the course of radio telegraphy in the U. S. Radio School, Parkway Building, Philadelphia, Pa.

More than 300 students are taking the course. The school is under the direction of Lieutenant G. Y. Cadmus, U. S. R. C., and was established when the government decided to educate a corps of several thousand radio operators for marine service.

According to reports issued by the staff of instructors the end of the first six months' course will see more than 400 operators graduated from the school, who will be licensed as second-class operators. It is also said that a number of the men will be recommended for the special course in radio telegraphy given at Princeton University.

Previous to the graduating of the present class of students at the radio school in the Parkway Building, enrollment for the second class will start. According to plans announced by those in charge of the school, preparations will be made to accommodate more than 500 pupils. The government will need more than 5,000 wireless operators for marine service within two years.

A WORLD'S RECORD: RADIO HEARD 13,000 MILES.

A radio message has been intercepted half way around the world at last. Using an Audion, radio operator J. L. Davies at Radio Awarna, Invercargill, New Zealand, has accomplisht this feat. In a recent letter to Dr. Lee de Forest, the well-known radio authority, Mr. Davies says in part:

"In my experimental work at present it may interest you to learn that using Audion bulbs of the double grid, double plate type, I am daily receiving stations antipodally situated in respect to this station. Distances of 13,000 miles are covered and some of the many stations at about that distance that I pick up are Eilvese, Germany; Eiffel Tower, Coltana, Las Palmas, etc., Eiffel Tower is easily copied on the typewriter, owing to the geographical position of my station." The distances mentioned are indisputably world records.

BEING A NAVAL WIRELESS MAN.

By Howard S. Pyle.

Electrician Radio, U. S. Navy.

AS I sit here on watch in the early morning hours, I think of many things and my thoughts naturally turn to the good old amateur days "back home" where we used to "cuss the other fellows" for QRM more than we would OK for bix from the whole "Ham tribe." Those were indeed the "Happy days" but are now temporarily a thing of the past. But why should we lose the fascinating recreation of listening to the song of the spark? Why? I asked myself that question when we were closed down and decided not to. I hiked myself to the nearest Marconi office and got an assignment—back on the dear old air again and—contented. But commercial service today is not what it was before the war. Very little bix I found, handling only four or five messages an entire trip of eleven days and on a passenger boat with a full passenger list too. To the real dyed-in-the-wool "Ham," this business of three or four "msgs" a week is not particularly attractive for the more bix the better, as we get a chance to operate then. I felt that way about the commercial game so, knowing many of the fellows who had entered the Navy service, I decided to look into the thing. None of them appeared to be over-enthusiastic about Navy wireless.

I almost felt sorry for them for I never have considered pounding a key work, so I went farther. The Navy Yard was my next port of call and there I had a talk with the DCS (district communication sup't), a Naval Lieutenant. He offered me an assignment to NPD and painted a word picture of the place which, altho not making it appear a particularly attractive berth, yet seemed to offer great opportunities in the wireless game so I entered the service as "Electrician Radio" and received orders to report to Tatoosh Island, NPD, at once for active service.

After a succession of circumstances I found myself at the Island—a large rock of about 17 acres extent. A government weather bureau, lighthouse and wireless station just about occupied all the available space and the buildings were of the usual substantial, neat construction characteristic of all Government institutions. I reported for duty and was assigned sleeping quarters which I was surprised to find equal to a first-class hotel, as I had imagined it to be rather a primitive life on the Island. Quite the contrary, tho, as we have all modern conveniences such as hot and cold running water, electric lights, bath, etc. I also found the enlisted men fine fellows and very congenial; feeling at home with them right away. At "mess" another surprise greeted me in the excellent quality (and quantity) of the food served. Altogether my first day was a succession of surprises. I found the "Electrician in Charge" a man of the highest type and he gave me my first day to *get acquainted.*

The following day I broke in, taking a regular watch, which is varied each day so that no operator has the same watch in succession, permitting a full night "in the hay" every fifth night. I was given the Mid-watch or from midnight to 4 A. M. (we only work 4 hours a day) and found no business that 'eve, which was indeed lucky as it gave me a chance to get used to the outfit and forms of Government transmissions. However, since that time I have found each watch busy enough to satisfy me without rushing a fellow.

On the whole I am well pleased with Navy wireless and am considering staying with it at the close of hostilities.

I also know that I am doing my bit for "Uncle Sam" and want to urge every amateur and operator to enter the service if at all possible, as The Navy is in great need of wireless men and it is your chance to serve your country. In addition to this you receive the best training in the art that is possible, for the Government does things right.

"Upholding the Stars and Stripes and the EXPERIMENTER."

I remain (what we would call a 100% American) ARTHUR J. BARRON.

SUCCESSFUL LOOSE COUPLER BUILT FROM "E. E." SUPPLEMENT

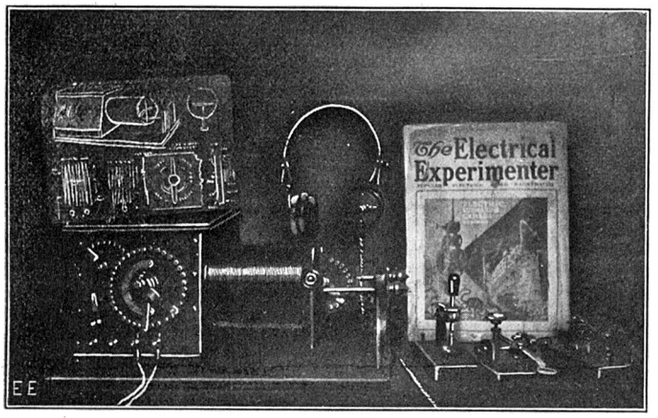
Herewith is a photo of the Receiving Transformer I built from the Blue-print *Supplement* of the EXPERIMENTER, but the photo does not give the instrument justice because it does not show the color and workmanship, but it is a "beauty" and it is a 5,000 meter instrument.

I am building an Oudin high frequency coil as described in the May EXPERIMENTER and expect to have it completed soon.

I sure do like the "E.E.", I would not take a hundred dollars for the copies I have on hand if I could not get any more like them; they have helped me up to where I am now, I am an *Electrician* by trade and an EXPERIMENTER after work hours. I am building nearly all of my apparatus.

I have been reading the "E.E." for about two and one-half years and when I want to learn something that I don't know I consult the EXPERIMENTER and I nearly always find it.

The EXPERIMENTER is the experimenter's "STAND-BY."



Now and Then We Do Hear from Our Readers. Here's the Fine Loose Coupler One of Them Built from a Description Given Some Time ago in "The Electrical Experimenter."

FIRST WOMAN RADIO OPERATOR GRADUATES AT HUNTER COLLEGE, N. Y.

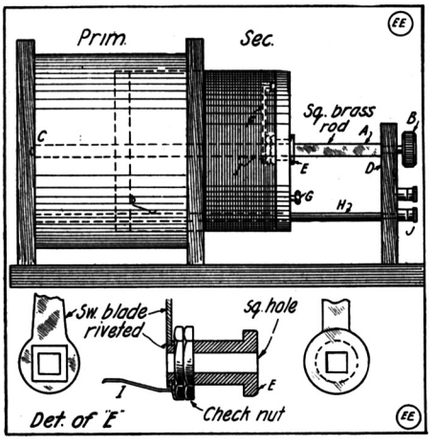
The women of America are rapidly coming to the front in military affairs, as witness the accompanying illustration of Miss Elizabeth Rickard, first radio graduate of Hunter College, New York City. This institution has a very enthusiastic wireless class who are blest with every provision for quickly assimilating the intricacies of radio telegraphy. The Marconi Wireless Telegraph Company of America presented the college with a standard commercial radio transmitting and receiving apparatus. Special instructors have been provided also, so that the girls who graduate here are fully equipt to take up commercial or naval duties. The U. S. Navy Department has intimated that women radio operators may be placed in charge of land stations, and in this way relieve badly needed men operators for active duty on board ships or abroad. The new merchant fleet which the Shipping Board is now building will also require a large number of radio operators. The outlook for radio operators is therefore very bright and after the war there will be plenty of work also for many years to come.

The First Woman Radio Operator to Graduate at Hunter College, N. Y. Miss Elizabeth Rickard Is Her Name and Uncle Sam Has Awarded Her a "First Grade Commercial License" as Radio Operator. Let Us Have More of 'Em.

Miss Rickard entered the Wireless Class for women at Hunter College in April, 1917, and was detailed to the Marconi School for intensive training in May. She past the test given at the Marconi School in the first week of July and received complimentary mention of her paper, her instructor saying it was the best submitted out of a class of 20 men and 3 women. On July 12th she went up for her Navy test and received the highest possible rating and was granted a First Grade Commercial License. Miss Rickard had done nothing in wireless before the first of January, 1917. She showed unusual ability.

A DUST-PROOF COUPLER-SWITCH.

Herewith is a sketch of a dust-proof secondary switch for loose couplers which has proven highly satisfactory, besides greatly improving the appearance of any



A Good Way to Build Dust-Proof Coupler Switches. The Square, Revoluble Shaft Turns the Sleeve to Which the Switch Blade Is Attached.

coupler. It also does away with expensive switch points as any old ones will do, as they are not seen. The blade is swung by turning the square brass rod A by means of knob B. This square rod goes thru bushing E or a counter bushing inside of E, which has a square opening. The switch blade is securely fastened to it. The entire switch and secondary move along the rod, but when B is turned, the switch rotates accordingly. A spring (I) may be used to make a better contact. The secondary may be moved more easily if a knob G is mounted handy as shown.

Contributed by NEVIN BRENNER.

PENDULUM OPERATED BUZZER TEST.

It may be attached to any clock, but one tector buzzer test by other means than a hand or foot-operated key, thus leaving the operator entirely free to manipulate the instruments. By utilizing the pendulum movement of a clock a very reliable automatic tester can be had and the operating expenses are nil.

It may be attached to any clock but one having a pendulum speed of about fifty to seventy beats per minute is preferred. If the clock is in the operating room it will operate the buzzer direct, otherwise a relay should be used.

Secure a piece of silver foil around the pendulum. Obtain a very thin spring several inches long (about No. 32 B & S gage) and wrap silver foil at one end. The other end is secured to the woodwork of the clock in such a manner that the pendulum just barely makes a contact on each swing. This can be ascertained best after the buzzer has been connected. Two leads are taken from the buzzer circuit, one is grounded to the metal frame work of the clock, the other is connected to the spring. Care must be observed that the spring is not too short or it will interefere with the proper working of the clock.

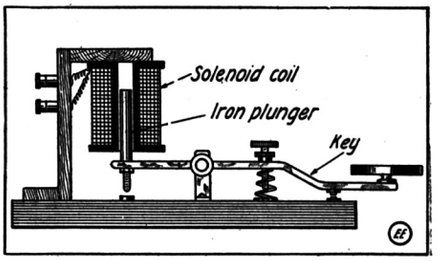
I have used an arrangement as described and found it "always on the job" when switched on. It also can be connected to your own radio transmitter to give imitations of NAA, etc. Of course a relay should always be used where heavy currents are to be handled.

Contributed by CHARLES M. FITZGERALD.

MAKING AN OMNIGRAPH OPERATE STUDENT'S HAND.

Train the hand as well as the ear to learn the code rapidly and proficiently. Receiving the dots and dashes thru the hand opens a new path. Rig up a telegraph key so that the lever may be worked up and down by a solenoid or sucking coil as per diagram. The solenoid is connected with a code machine such as the Omnigraph and the key adjusted to work like a sounder; then grasp the key as for sending, but let the key operate the hand instead of the hand operating the key. Combining this operation with regular sounder or buzzer practise enables one to become expert on the double-quick. Try it, "hams."

Contributed by FRANK COPEMAN.



A Clever Scheme for Learning the Code Easily and Quickly. A Magnetic Solenoid Connected to an Omnigraph and Battery, Works the Key. Thus the "Telegrapher's Touch" Is Acquired Unconsciously.

Development of Aircraft Radio in the Navy

By BENJAMIN F. MIESSNER
Expert Radio Aide U. S. N.

That the Navy realizes the necessity of organized scientific research of its special problems and the development of special apparatus to meet its peculiar requirements, is clearly manifested by the establishment of an excellently equipt radio laboratory at the Navy Aeronautic Station, Pensacola, Fla.

While radio signaling over the earth's surface is largely a standardized art now, aircraft radio, altho already an accomplisht feat, has thus far been largely a matter of cut-and-dry guesswork unguided by accurate scientific data. This laboratory, in addition to its work of testing aircraft radio apparatus submitted by commercial manufacturers, under both laboratory and service conditions, is gathering valuable scientific data pertaining to the peculiarities involved in radio signaling between isolated points above the earth's surface, and between such points and the earth's surface, as distinguished from the usual over-land or over-sea signaling. It is also developing special radio and other apparatus for naval aircraft. Being in extremely close touch with the actual aircraft conditions and requirements, this laboratory presents unusual opportunities for thoro study and development.

The naval officers having jurisdiction over this work are Lieutenants E. H. Loftin, District Communication Superintendent, stationed at New Orleans, La., and P. N. L. Bellinger, Head of Experiment and Test Division at this station.

Altho the laboratory has been in existence but a few months and is not yet fully equipt, several important problems have already been attacked and satisfactorily solved. Among these may be mentioned:

(1) The development of a simple interseat telephone for pilot-student or pilot-observer conversation on airplanes under the conditions of full power flight. This work was undertaken because commercial apparatus had proven entirely unsatisfactory. Two types have been developed, the first of which requires no external battery or power source, and which incorporates extreme simplicity and ruggedness in its construction, is suitable for use under the moderate noise conditions encountered on low powered airplanes; the second of these, which requires an outside battery, may be used under the most severe noise conditions obtainable on present airplanes without exhaust mufflers. These telephones, which are in daily use for instruction purposes, reduce by nearly one-half the time required for qualifying student pilots, by permitting constant coaching from the instructor, and are invaluable for pilot-observer communications for reconnaissance, spotting, or other flying in two-passenger airplanes.

(2) An exhaustive study has been made of the noise conditions affecting radio reception on airplanes. A special instrument, called the *Noisemeter*, was devised with which accurate measurements of various airplane noises have been made. Thousands of measurements have been made in determining the noise-making qualities of various aeronautic motors, the efficiencies of muffling devices, the intensity of the noises at varying distances and at varying motor speeds, the distribution of the noises in different directions, the efficiencies of radio headgear for eliminating airplane noises, the effects of airplane noises on the ears, the noise-making qualities of air at varying velocities, etc.

(3) Exhaustive measurements and tests are being made on every conceivable form of airplane antenna to determine the advantages peculiar to each type.

(4) The most recent development is an entirely new type of radio transmitter, which constitutes what is perhaps the greatest advance thus far made in aircraft radio. With an outfit having a total weight of only *five pounds*, designed particularly for spotting work, a signaling range of from *ten to twenty miles* is easily attained. The space considerations are negligible. With another larger outfit, weighing only about *ten pounds*, a range of from *fifty to seventy-five miles* is obtainable. These weights include the antenna system necessary for radiating the radio energy. The full significance of these statements is not realized unless it be added that the very best commercial apparatus now obtainable weighs from one to two pounds per mile of range, and occupies a space of from one to two cubic feet per twenty-five miles of range, making necessary the removal of the forward controls.

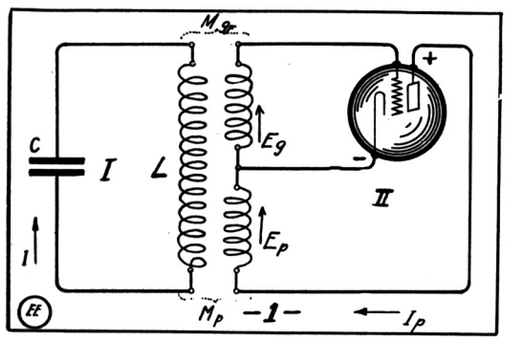
(5) The establishment of radio instruction classes for officers undergoing pilot training has not been neglected. Group instruction in operating, and the functions and care of the various parts of radio apparatus, is given on such days as are unsuitable for actual flying.

(6) Other devices being experimented with are aircraft and submarine detection apparatus and radio direction-finders for aircraft.

September Meeting of Institute Radio Engineers

A VERY interesting and instructive paper was presented by Prof. L. A. Hazeltine, September 5, 1917, at a meeting of the Institute of Radio Engineers held in the Engineering Societies Building, New York City.

The paper, which is the first of a series to be presented this season by the Institute, covers the subject of the Audion from an entirely different side than ever before read before the Institute. Prof. Hazeltine showed by diagrams and stereopticon views the feasibility of measuring the curve of the transposed energy from the grid to the plate and the formulas for calculating this quantity. By so doing he illustrated the method of determining whether an Audion would oscillate or not, and if the curve was too broad, the Audion would probably not act as a receptor, but could be used as an oscillator or amplifier.



In This Diagram I Represents an Oscillatory Circuit Which Is Excited by a Suitable Means and Current Transferred Inductively to Two Split Inductances, Which by Virtue of Their Position Produce Regenerative or Oscillatory Action in the System.

The subject certainly aroused quite an interest in all present, and Prof. Hazeltine was highly commended on his treatment of a heretofore unthought of phase of the Audion. The lantern views showed past and present Audion hookups and also an idea of those to be experimented with in the future. Also a discourse as to the merits and demerits of the various circuits.

The paper was discust by many prominent men, among whom was Dr. Lee de Forest, who spoke a few words outlining the present status of the Audion. Mention was also made of the Audion being used to check various measurements owing to the high per cent. of its efficiency and almost negligible per cent. of errors.

The subject for the October meeting was "Radio Telegraphy in Competition with Wire Telegraphy in Overland Work" by Robert Boyd Black, U.S.N.R.F.

EFFICIENCY IN RADIO TRANSMITTING CIRCUITS.

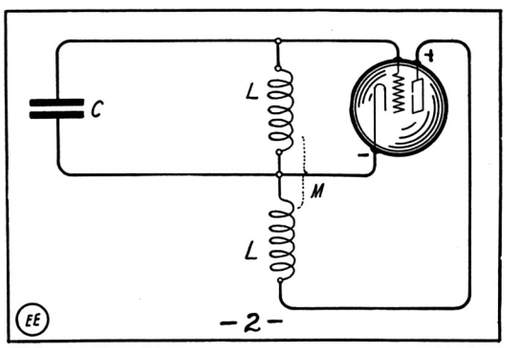
By Bayard Shumate.

THE efficiency of the average amateur radio transmitter is very low and is usually due to carelessness regarding small details, rather than to poor instruments.

In the first place an efficient transformer costs little more than a poor one, so it is advisable to purchase it from a reliable firm. As the maximum input allowed is only 1,000 watts, as little energy as possible should be lost in the transformation. A choke coil should be inserted in the primary circuit, as it is invaluable in close tuning as well as in preventing arcing at the spark gap. A good one was described in a previous issue of this magazine. The core of this coil should be about the same size as the leg of the transformer.

The condenser is probably the source of greatest loss in the amateur station, for most of them seem content with any old kind they happen to think of. A condenser that brushes or that has poor connections loses about half of the energy supplied to it. Thin sheet brass makes excellent coatings for the plates and the cost is not prohibitive. The lugs should be one inch or more wide and carefully soldered to the plate. The series-parallel connection should be employed if possible, as it gives almost entire freedom from puncture and minimizes brush losses. Four banks, each of the capacity required for the transformer, are connected—two in series and two in parallel. As each section handles only one-fourth of the voltage, thin glass may be used. The dielectric strength of a thin dielectric is much greater in comparison to the voltage required to puncture it than that of a thick dielectric. Thus the use of thinner plates allows the use of a fewer number with the same capacity. Glass losses are reduced in this way also. This type of condenser when immersed in a good grade of oil gives excellent satisfaction.

High frequency resistance is much greater for short wave lengths than for long, so the amateur is handicapt by this also.



This Audion Diagram Represents Another Method of Coupling Inductively the Plate and Wing Circuit. In This Case Condenser C, Is Shunted Across the Wing Inductance Permitting Greater Freedom of Tuning Grid Current.

The frequency of an oscillatory current at 200 meters is enormous (something around 1,500,000), therefore all connections must be made with conductor having a large surface. Conductors containing 50 to 100 strands of No. 22 bare wire, twisted together, are commonly used but heavy brass strip is preferable where possible. Those of the primary circuit should be very short and should not exceed 20 inches. The condenser, gap and oscillation transformer can readily be arranged to allow these short leads. The transformer may be set anywhere and the current may be supplied to the two condenser connections thru small wires (No. 18 to 22), which have been coiled into a spiral. These spirals form choke coils, which aid in preventing arcing at the gap and prevent kick-backs. (See "E.E." for January.) If any conductor heats to the slightest degree, it should be replaced by a larger one, for the energy lost in producing this heat means many miles less effective range.

Almost any standard rotary will give good service if it is not run too fast. It is true that a high tone is more audible than a low one, but on a 60 cycle current the condenser cannot be properly charged when a very high tone is used. It is best to use a medium tone so as to combine the audibility of the higher tone with the powerful condenser discharge of the lower.

The oscillation transformer loses energy due to the inductive coupling. It should then be large enough to secure a proper transformation of energy and not too loosely coupled. Three inches is enough for a half kilowatt set and will give a sharp wave if properly handled. A sharp wave depends more upon resonance than upon coupling, tho a sharp wave cannot be secured if the coupling is too close. A good method of tuning is as follows:—

(1) Connect a hot wire ammeter in the aerial circuit, set the coupling at about 4 inches and connect the entire secondary in the circuit.

(2) Adjust the primary clips until the meter shows the greatest radiation.

[*Note: If more than two turns of primary ribbon are necessary the condenser is too small and must be enlarged accordingly.*]

(3) The ammeter is now removed from the circuit as it damps the oscillations. The set is then tested for sharpness with a wave meter. This need not be an expensive instrument. About twenty turns of insulated wire (18 to 20) are wound on a tube 4 or 5 inches in diameter and connected in series with a small battery lamp and variable condenser. This will be sufficient for comparative readings. If the lamp lights over a large number of degrees on the condenser scale, the wave is broad. Then move one of the secondary clips around one turn of ribbon, a little at a time, until the lamp will light over ten or fifteen degrees only. If the wave cannot be tuned sharply by this means, the coupling is too close and must be moved back. If the wave is found to be sharp, the coupling may be tightened until it begins to broaden a bit. If it can be sharpened again at this point it will be to advantage. The point is to get the wave sharp with the coupling as close as possible. A sharp wave is advisable for long distance work because no energy is wasted in the waves aside from the one affecting the receiving station.

The aerial conductors should be stranded if possible and of course as high as possible. They should not be over 110 feet in total length to have a 200 meter wave. The wires should be widely spaced as a few wires widely separated have a larger capacity than many wires close together.

Thus efficiency results from careful attention to small details, for if a single detail is slighted it means the loss of energy —something that the amateur has little enough of to start with.

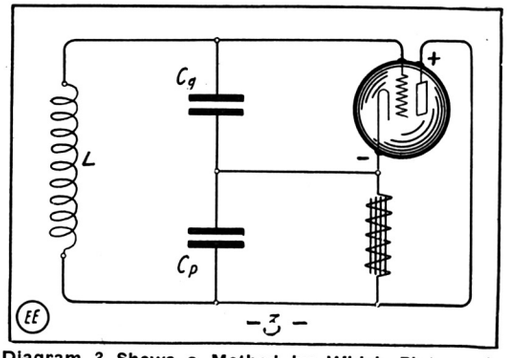


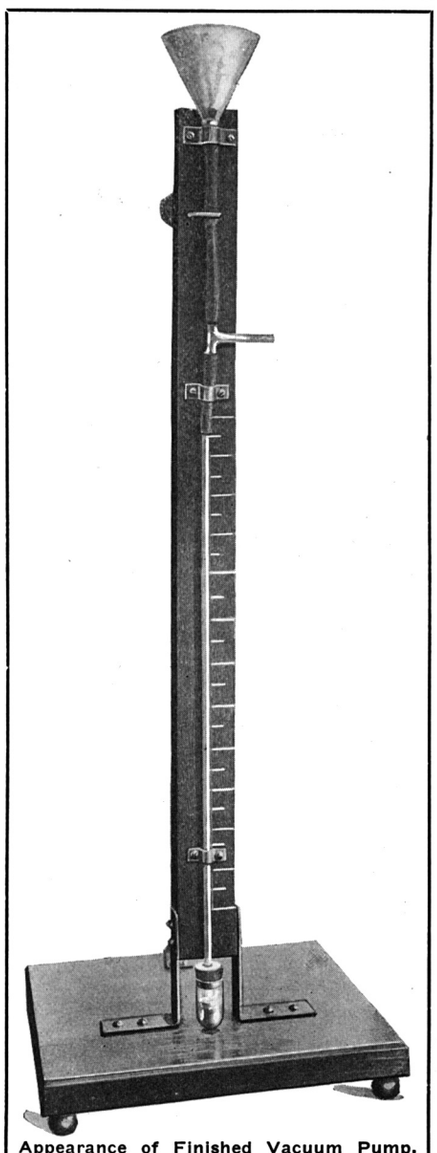
Diagram 3 Shows a Method by Which Plate and Wing Units Are Coupled Electrostatically Thru Condensers Cg and Cp.

THE CONSTRUCTOR

Construction of a Laboratory Vacuum Pump

By RAYMOND FRANCIS YATES

A GOOD vacuum pump should be included in the equipment of every laboratory, but, owing to the prohibitive price of such machines, the experimenter generally finds it impossible to purchase one. The following



Appearance of Finished Vacuum Pump, Details for Constructing Which Are Given Herewith.

paragraphs describe the construction of a pump that is capable of creating a vacuum as high as 1/1,000,000th of an atmosphere (equivalent to .00003 inch of mercury). The total cost of construction should not exceed $3 including the 22 ounces of mercury necessary to operate it.

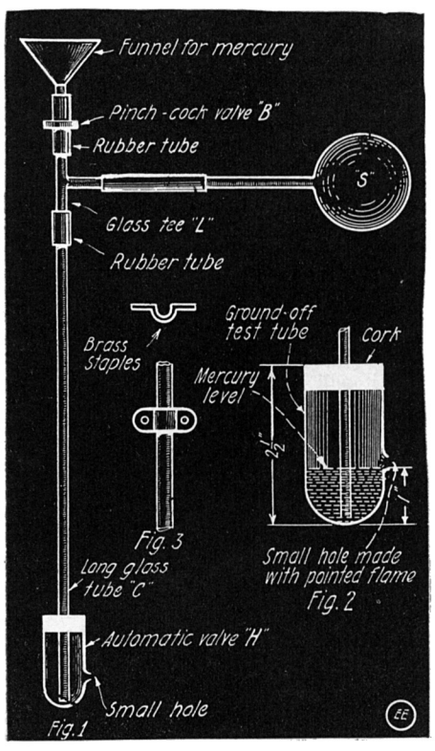
The principle upon which the pump works was first discovered by Torricelli, and Geissler of Bonn, Germany, was the first inventor of an apparatus utilizing the Torricellian principle for creating high vacua in enclosed vessels. Geissler's vacuum pump, however, was very complicated and somewhat costly and Dr. Sprengel later made many improvements on it, not only making it more convenient for the laboratory, but increasing its efficiency and making it much easier to manipulate.

Before starting the actual construction of the pump, it is advisable that the builder become sufficiently acquainted with its theory of operation to proceed in making the various necessary parts in an intelligent manner. The experimenter, Torricelli, discovered that a column of mercury passing thru a tube with a small bore pushed the air in the tube before it and left a vacuum in its wake, providing one end of the tube was closed to prevent the re-entrance of air. Referring to Fig. 1, it will be seen that a small column of mercury passing down the long glass tube "C" will act as a piston and push the air before it into the automatic valve "H", which permits the air to leave but makes it impossible for it to re-enter. The passage of the mercury from the reservoir into the tube is controlled by the valve "B" and the vessel to be evacuated is connected to the glass tee "L".

The automatic valve is shown in detail in Fig. 2. With a little study it will be seen that when the test tube is filled with mercury air may escape from the glass tube thru the small hole but the mercury prevents the air on the outside from re-entering. Every time mercury is dropt thru the long glass tube "C" the air in the vessel "S" becomes more rare until it is reduced to an infinitesimal fraction of its original value. From 20 to 30 minutes operation will produce a very high vacuum in a vessel with a capacity under .5 of a liter. When the air in the vessel "S" reaches a small value, the mercury in the tube "C" mounts to the barometric height of approximately 30 inches.

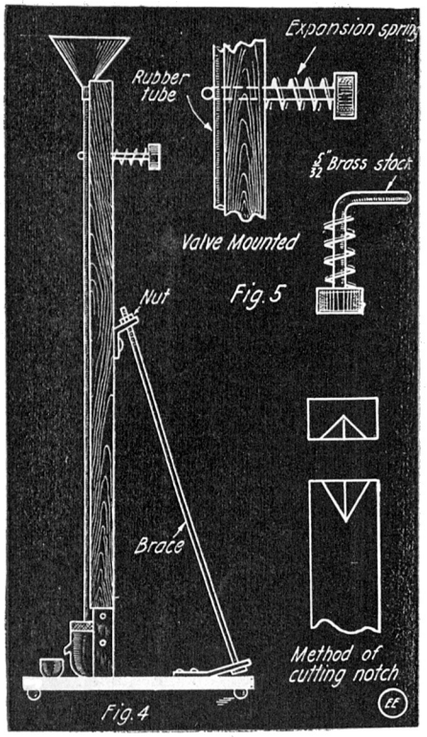
The first material required is the standard on which to mount the long glass tube, and a base. These are cut from quartered oak. The base is 9 x 9 x 1" and the standard is ¾ x 1½ x 36". Both should be cut accurately and sandpapered. A notch is then cut in the top of the standard as shown: this is to accommodate the glass funnel which holds the mercury. After this, the base and the standard may be varnished. Obtain two brass angles and fasten them to the standard as shown. The glass tube should be about 31" long with a bore not exceeding 3/32". The tube is fastened to the standard by means of four small brass staples as shown in Fig. 3. Care should be exercised in screwing the staples to the standard as the glass tube will crack if pinched too tightly. After mounting the tube, the standard should be fastened to the base by means of the brass angles. Owing to the inability of the angles to hold the standard rigidly because of its height, it will be found necessary to provide a brace at the back of the standard. This is shown in Fig. 4. The brass rod should be about 18" long. A glass funnel about 3" in diameter should be purchased and its stem reduced to about ¾ of an inch by grinding it on the corner of an emery wheel and breaking the larger portion off. The funnel is then mounted on the top of the standard by means of a small brass staple. The funnel is so fastened to the top of the standard that it will rest in the notch previously cut. Such procedure is absolutely necessary owing to the great weight of the mercury in the funnel.

The glass tee should have a bore about the same size as that of the large tube. Such tees may be purchased from any chemical supply house for a few cents and the writer would not advise any builder to attempt to make one unless he is thoroly experienced in glass blowing. The tee should be connected to the end of the funnel and the long glass tube by means of heavy rubber tubing just large enough to fit snugly over the top of the glass. Be-



Important Features of Ideal Mercury Vacuum Pump for the Experimenter, Including Details of Automatic Over-flow Valve.

fore the rubber tubing is put on, the glass should be smeared with a thin layer of vaseline. After the rubber tube is put on, black thread is wound tightly around each



Side View of Home-made Mercury Vacuum Pump Which Is Suitable for Exhausting Geissler Tubes, X-ray Bulbs, Lamps, Coherers, and a Host of Other Things Dear to Every Experimenter's Heart.

joint and another application of vaseline is smeared over the thread and joint. This procedure produces a joint that is very near to being absolutely air-tight and such joints are positively necessary to the successful operation of the pump.

The little valve at "B" was developed by the writer and is simplicity in itself. It is shown in detail in Fig. 5. By pressing the knob, the pressure of the arm on the tubing is overcome and mercury is permitted to flow (for a fraction of a second) from the funnel into the tube. Releasing the pressure causes the spring to bring the arm back to its original position where it pinches the rubber together and prevents the flow of mercury. When the pump is not in use, the arm should be turned so it will not come to rest upon the rubber tube as permanent pressure will injure the tubing.

To indicate the degree of vacuum attained at any stage of the operation, it will be necessary to make a suitable scale on the standard at the side of the long glass tube. The lines are drawn ½" apart and after marking them with a soft pencil the lines should be painted over with white "show-card" ink applied with a very small brush. Such a scale stands out prominently and adds to the appearance of the instrument considerably.

When the pump is operated, the vessel to be evacuated should *not* be connected to the tee by means of a long rubber tube as the tube will be pressed together by the atmospheric pressure on the exterior (14.7 lbs. to the square inch) and the further passage of air from the vessel will be interfered with if not altogether prevented. This difficulty can be overcome by using glass tubing with small pieces of rubber at the joints to produce flexibility. All joints should be prepared according to the preceding directions.

When the pump is operating properly, the mercury will fall thru the long glass tube in separate little columns and each column acts as a piston pushing air before it. The valve at the top of the standard should be manipulated intermittently until the mercury in the tube rises to about 30 inches. This will indicate a vacuum sufficiently high for ordinary purposes.

A small receptacle is placed under the hole in the test tube to receive the mercury as it overflows. When the receptacle is full, the mercury is poured back into the funnel. *Do not permit all the mercury in the funnel to run out as this will destroy the vacuum.*

REGARDING TESLA AND OUDIN COILS.

By Carl H. Rauschenberg
Experimental Engineer

I present herewith two photos illustrating my cone-shaped high-frequency coil in operation. The photo Fig. 1 shows the enormous brush discharge from a wire attached to the upper terminal and also the discharge from top of coil. The photo Fig. 2 shows the spark discharge from a ball terminal placed on top of the coil to a grounded conductor.

This coil is very similar to one described in the "E. E." a short time ago (see May, 1917, issue). It was excited by a ¾ K. W. Thordarson Type-T transformer and an oil immersed condenser of about .008 M. F. using small 8-stud rotary gap running at 5,000 R. P. M.

The building of the coil was not so difficult, the method of building the secondary cylinder being somewhat different from usual practise. I went to a tinshop and told them to make me a cone of heavy galvanized-iron 15" dia. at bottom, 7" at top and 20" high; *seamed on the inside.* This gave a perfectly smooth outside surface. I set this form on a table and cut large pieces of ordinary building paper of a shape to fit around it. I just merely built up the paper using ordinary glue until I had a thickness of about ⅛". The paper can be cut so that it will fit the cylinder perfectly. The best method is to watch the tinner cut out the iron for the cone, take the dimensions he uses and cut your paper the same way. If the first piece of paper is cut the same size as the tinner cuts the metal it will be found to overlap slightly when fitted around the coil. This is as it should be and glue should only be put on the lap so that the paper is not glued to the form which must be removed later. After the first sheet is in place cut another sheet to the same dimensions and trim the edges till they just meet, fitting the paper before applying glue. Spread the sheet of paper on the floor, give it a thin coat of hot glue and quickly apply it to the form. Continue in this way until the desired thickness is attained. About 10 to 12 sheets will be sufficient. The joints should be staggered at various intervals around the cylinder of course. Leave the paper on the form for 48 hours or until perfectly dry and hard. Remove and give two coats of shellac inside and outside.

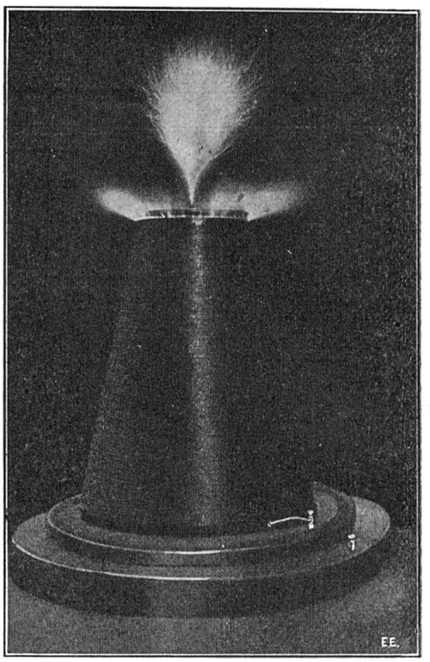


Fig. 1. Illustrating the Vigorous High Frequency Discharge From Free Electrode, As Well As Top, of Oudin Coil of Good Design.

The winding was done in the usual way using a string to space the turns and the finished winding given 5 coats of shellac to insulate it and hold it in place. The size of wire is not so important, mine being wound with 27 D.C.C. wire. Enameled wire should not be used.

Primary consists of 4 turns of copper ribbon, ¾" wide wound into a spiral with a thickness of ordinary corrugated pasteboard (cut from a bread carton secured at a local grocery), between the turns. Primary leads are connected to binding posts leading to ends of primary ribbon; thus the entire 4 turns are always in circuit, tuning being accomplished with the secondary of a wireless oscillation transformer which is placed in series with condenser, spark gap and primary of Oudin coil; the wiring diagram shown in "E. E." several months ago being used.

I find the spark length from the Oudin type of coil to be not so long as that from the Tesla type with a given amount of power, but much heavier and capable of experiments not possible with Tesla type.

Some wonderful results can be had from the ordinary wireless sending set and in my opinion no amateur will regret the time and money spent in the building of a coil for use on his sending set.

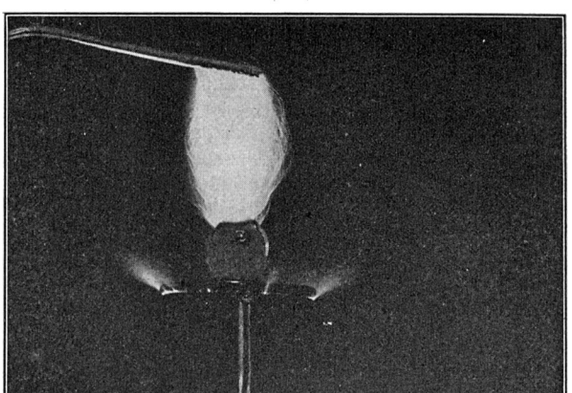


Fig. 2. Showing the Powerful High Frequency Spark Discharge From a Ball Terminal on Oudin Coil to a Grounded Conductor.

Due to the advent of the war, we are particularly desirous of obtaining snappy manuscripts describing original and practical "Electrical Experiments."

A SHOCKING ELECTRIC ALARM FOR COMMUTERS.

We all have made and used at one time or another some form of that torturing device known as *The Early Riser's Alarm.* At first the regular electric bell was sufficient to rouse us out of bed in time to catch the early train, but it soon lost its wakening powers with the result that a hundred yard dash was necessary to get even the late train. We then installed an electric horn made from a tin can and a bell. That worked fine for a time and then it failed to give us that sudden shock that should accompany our awakening to get us out of bed *immediately.* We had gotten used to the racket and could not increase it any without bringing down the wrath of the neighbors.

The writer tried them all, even considered the use of a small cannon or a device to pull one leg from under the bed but dropt them all in favor of the scheme described here.

The clock used possest no original features but its simplicity may be of interest. Examining Fig. 1, it will be seen that a block of wood was mounted just below the winding key for the alarm. A strip of ⅛ inch brass was fastened to the block in such a way as to prevent the key making more than a quarter turn when the alarm went off. Wires were connected to the insulated strip and to the framework of the clock. It was then a simple matter to set the alarm and it was likewise necessary to arise to turn it off in the morning. A switch may of course be included but it is unnecessary; you will get up anyway.

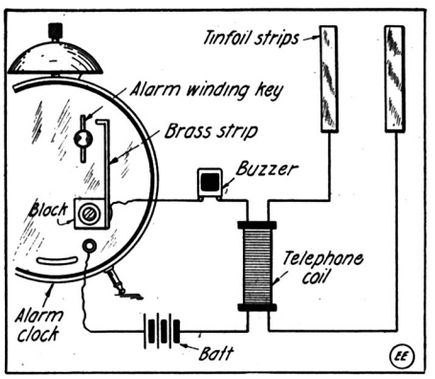
The other parts consist of several dry cells, a buzzer, a small induction coil (a ¼ inch spark coil or a telephone induction coil will do) and two strips of tinfoil 3 or 4 inches wide and 2 feet long.

These are wired according to the diagram in cut; the buzzer being unnecessary when the usual spark coil is employed. The tinfoil strips are laid under the sheet on the bed and separated a distance of about three feet.

Now let us see what happens when "Big Ben" closes the switch. The buzzer will interrupt the circuit, causing high voltage currents in the secondary circuit that find a path thru the innocent sleeper's body by jumping thru the thin sheet that separates him from the tinfoil electrodes. It is borne forcibly on him that his presence is not desired any longer. A departure under such circumstances is accepted as the usual thing by most persons, who will then start the day with zest and vigor.

Try this, "Bugs," it won't hurt you.

Contributed by THOS. W. BENSON.

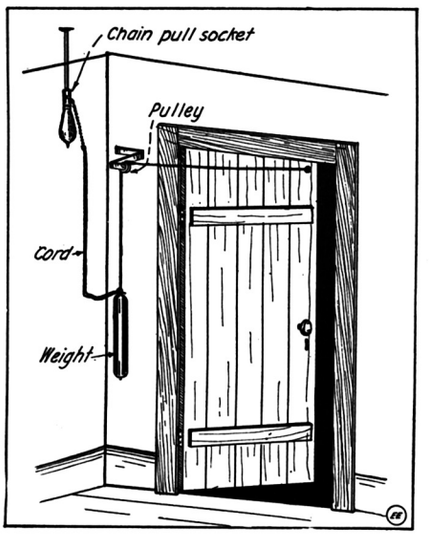


Are You a Commuter? An Ingenious Experimenter Has Perfected a Sure-Fire Electric Ejector for All Such. Simply Connect the Circuit-Closer to Your Clock; Hook Up a Buzzer, and Telephone Induction Coil as Shown and Also Two Tinfoil Strips, Laid Under the Sheet. When 5 A. M. Arrives, You Will Awaken—Never Fear.

LIGHT CONTROLLED BY OPENING AND CLOSING DOOR.

Not long ago I had occasion to install an electric light in a cellar closet used for storing vegetables. It was important to keep the door of this closet open as little as possible, that the temperature might be kept as low as possible, and for this purpose the door was closed by a weight and rope arrangement. Moreover, servants were frequently obliged to enter or leave the closet with both hands full. It was therefore necessary to install a light which would be automatic in action, and would not require the door to be kept open while the light was burning, as is the case with several of the automatic door switches now on the market.

All these difficulties were met at once in a very simple manner. A common pull socket was installed, and the chain of the

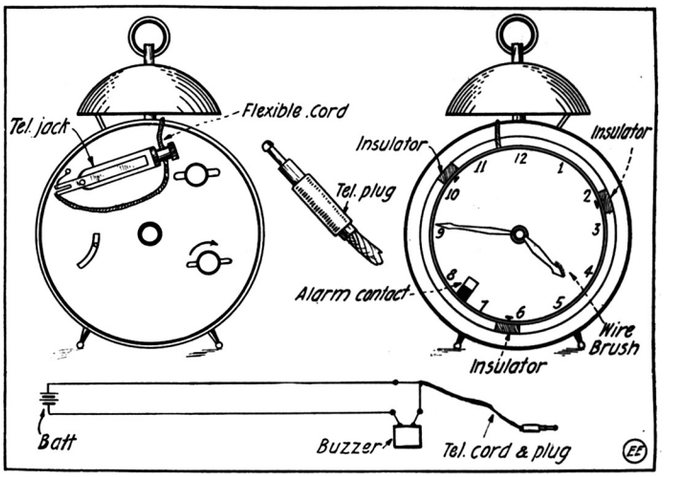


It Is Often Desired to Have a Door Control a Lamp, Such as in Cellars, Garrets, Etc. By Attaching a String and Counterweight to a Chain-Pull Socket, the Problem Is Solved.

socket was connected by a cord with the weight used to close the door, in such a way that when the weight was as near the floor as it could go, and when therefore, the door was closed all the way, the cord was pulled taut, and the chain with it. The result of this was, that when the door was opened, the weight was raised, the cord loosened, and the spring of the socket drew the ratchet back, engaging the switch; when the weight pulled the door to again, the cord was again tautened, the switch operated, and the lamp lighted.

The results of this arrangement were these: The switch was entirely automatic, being operated by the opening and closing of the door. When one enters the closet, the light is lighted, when one leaves, it is extinguished. The light is not turned on until the door is closed, so there is no inducement to leave it propt open, to save trouble in opening with the hands full, but also to fill the closet with warm air. The whole apparatus consists of an ordinary chain-pull socket and a piece of cord, thus obviating the mortises necessary in the ordinary door-switch, and making a very much simpler and cheaper installation.

Contributed by THOMAS T. HOOPES.



By Employing a Telephone Jack Switch as Shown, It Is Possible to Disconnect the Electric Alarm Attachment from the Clock Instantly. A Very Desirable Feature.

USING TELEPHONE JACK TO CONNECT ALARM CLOCK.

Having seen a number of electric alarm clocks of many fearful as well as ingenious designs in the "E.E.", including the one in the January number, I show above for approval one that I have had in use for over a year with excellent results. Most of those previously publisht make contact when the alarm spring unwinds. In the clock I have, the winding spindle does not turn when the spring unwinds. The arrangement I have differs from those previously described, as it does not depend on the alarm spring. The clock is separate from the rest of the circuit and may be used elsewhere when the alarm is not needed. When the alarm is wanted, simply hang the clock upon a hook and insert the plug in the telephone jack mounted on the back of the clock. Place the alarm contact on the dial at the hour desired. The battery may be placed in the attic or cellar, the wire fished thru the partitions, and brought out at the binding posts. Mount the buzzer and telephone cord as per drawing; connect one lug of the jack to the frame of the clock, the other to a ring made from a shade holder in the front and insulated from the clock by three small fiber blocks. When the hour hand comes in contact with the alarm contact, the buzzer operates.

Contributed by HOWARD D. DYE.

RENEWING DRY CELLS.

I have been experimenting with dry batteries for over a year, to find a renewing solution and I have kept a worn out dry dry battery alive with the following solution, for over six months:

Hydrochloric acid, 12 ounces.

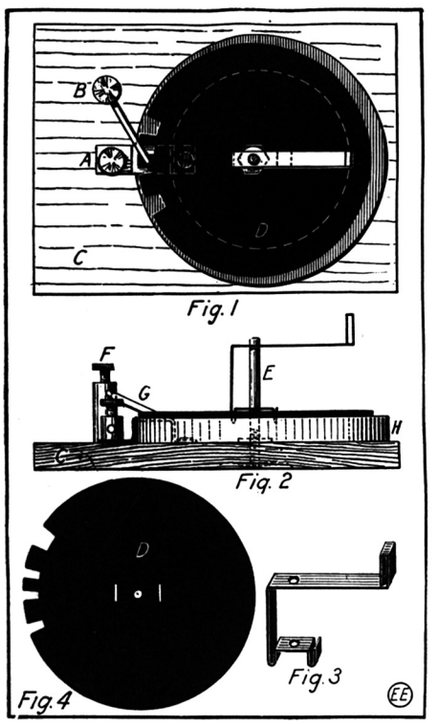
Add scrap zinc till acid stops boiling; use earthen jar.

The sealing wax is to be removed from top of dry of battery, the loose carbon surrounding the carbon proper is to be loosened (an ice pick will do this) and the acid solution poured in till the loose carbon is thoroly wet, but not muddy. The battery is then resealed, and is ready for immediate use.

Contributed by JOHN BLACKHURST.

A HOME-MADE CODE-LEARNER.

Figure 1 shows the base and the dimensions are left to the builder. The wooden ring should be about ¼" thick and ½" wide. A is a brass or copper strip sunk even with the surface of the ring; it is fastened inside with a screw and outside with a binding post for connection. B is a binding post with two holes, one for a connection, and the top one for a strip



Home-made Code Transmitter Constructed from Cardboard Disc, a Hand Crank to Turn it with and a Contact Spring Which Closes the Sounder or Buzzer Circuit.

of brass or copper pressing on A to make contact. C is the base to which the wooden ring D is glued. Fig. 2 is a side view of the machine. "E" is a brass rod in the center of the ring, over which the disk (Fig. 4) and the crank (Fig. 3) slip. Fig. 3 shows the crank, which is about ¼" wide with holes bored in so as to slip over E. Fig. 4 is the disk which is made of thin cardboard with the dots and dashes cut out as shown. Connections are taken off at the two binding posts and connected to a battery and buzzer.

Contributed by
FRANKLIN McTAVISH.

REMOVAL OF INK STAINS.

The tartaric acid and citric acid ink remover combination leaves a yellow stain. It affects only fresh stains appreciably, and even then does not remove them well at all.

The only method that I have found satisfactory for fresh stains on paper, is the following two solution remover, the concentration of which may be varied in individual cases. Two parts of concentrated borax solution are dissolved in ten parts of water and one part of citric acid added, this forms the first solution. The second solution consists of three parts of calcium chlorid, ten parts water, two parts of concentrated borax solution. The calcium chlorid should be dissolved in the water, the mixture set aside for a few days and only the clear supernatant liquid used.

The first solution is generously applied, the excess removed, and the second applied. The spot should finally be washed with water.

Contributed by J. FIERSTEIN.

AN EXTREMELY SENSITIVE MICROPHONE.

The writer recently conducted some experiments in an attempt to construct a simple and compact microphone that would be extremely sensitive. The result of his work along this line is shown in the illustration.

A microphone transmitter was obtained and arranged to be mounted on the back of a shallow box just a little larger. The transmitter was of a recent type having a metal diafram with an insulated carbon button attached to the center. A carbon diafram transmitter cannot be used very satisfactorily.

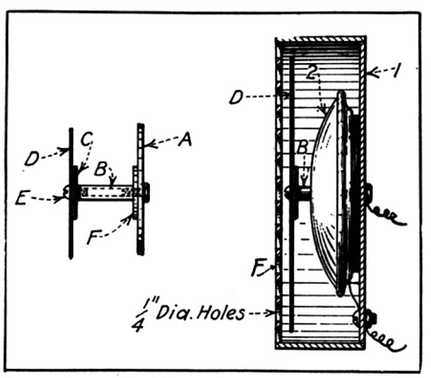
The nut was removed from the center of the diafram and a piece of brass rod one inch long and ¼ inch in diameter was drilled lengthwise and tapt with a No. 8-32 thread. A washer ½ inch in diameter was soldered to both ends of this rod as shown in the detail drawing at B, C, and F.

After substituting a mica diafram for the metal one the parts were reassembled with the short threaded brass rod instead of the nut in the center of the diafram.

A 4-inch disk of mica was then cut and by means of a small 8-32 screw and a washer fastened to the brass rod. The whole device was then placed in the box and connections made to the transmitter in the usual manner.

The front of the box was pierced with a large number of holes ¼ inch in diameter.

When properly made and assembled this device is very sensitive and will pick up the faintest sound. A method for testing the sensitiveness of such microphones that was found of value by the writer is to connect them in series with a receiver and battery and note the distance they can be held apart and still act on one another. The receiver and transmitter should first be brought close



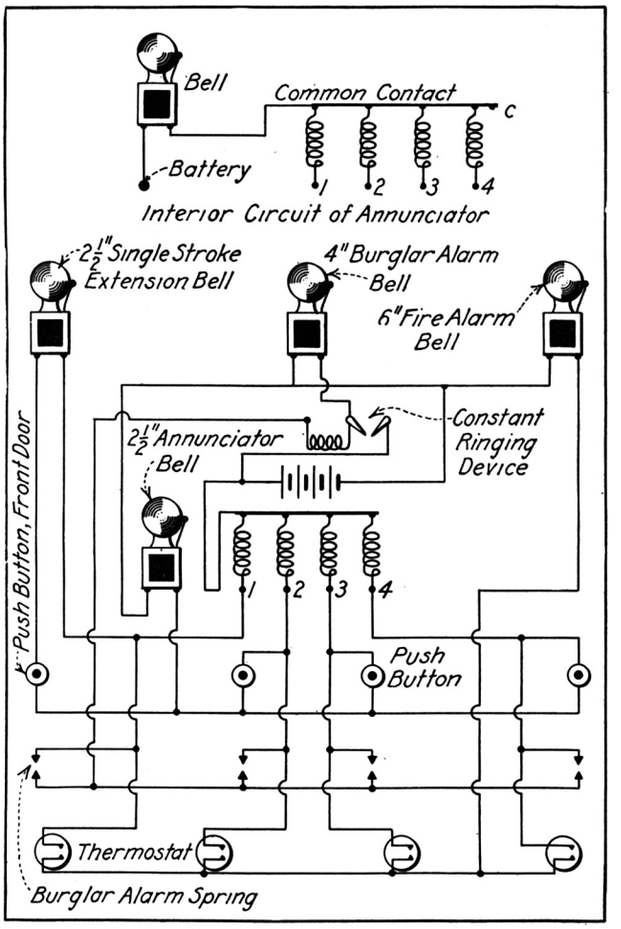
Reconstructed Microphone Possessing Extreme Sensitivity. Suitable for Dictagraph Purposes.

together and when they whistle, separate them slowly, noting the distance between them when the note ceases. This instrument will give an audible note when 2 feet from the receiver with four volts.

Contributed by THOMAS BENSON.

COMBINED CALL BELL, FIRE AND BURGLAR ALARM SYSTEM.

The scheme given herewith is to connect an ordinary four-drop annunciator, so that it may be used for a *call bell, burglar*



Hook-up for Combined Call Bell, Fire and Burglar Alarm System with Centralized Battery.

alarm and a *fire alarm* system simultaneously, to give location of call, etc., in all cases, and a constant ring for the burglar and fire alarm, and one extension bell to operate *only* from the front door, the bell on the annunciator operating also; if any other button is prest only the bell on the annunciator operates.

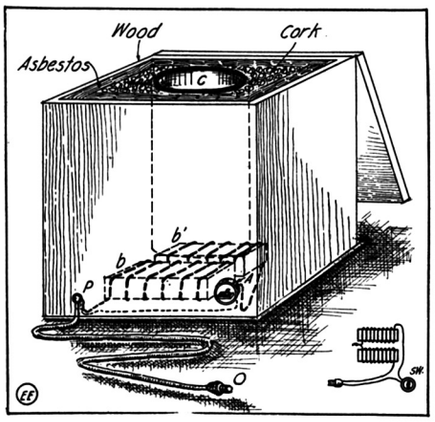
This is accomplisht by disconnecting the bell from the common wire which connects to the *drops*, and connecting the battery direct to this common connection. The opposite terminal of the battery connects to all bells, and the other side of bell acts as a feed wire for its particular system. A ringing device is used to give a constant ring on the burglar alarm systems, while the ordinary paraffin thermostats, which remain closed after paraffin has melted. serve to give a constant ring on fire alarm system. To get satisfactory operation on extension bell from the front door, a single stroke bell must be used; this, however, will operate as a vibrating bell due to the make-and-break of contact at the vibrating bell, which is in series with it. If a strong battery is used or a bell ringing transformer, two vibrating bells may be used on parallel.

Contributed by THOMAS J. HAYDEN.

Due to the advent of the war, we are particularly desirious of obtaining manuscripts describing original and practical "Electrical Experiments." We shall continue to publish Radio articles, but what we need is snappy "Electrical" articles.

HOW TO MAKE AN ELECTRIC FIRELESS COOKER.

A "Fireless Cooker" finds an important place in every home, especially one that



Why Not Build an "Electric Fireless Cooker?" Two Ordinary Bricks Wound with Resistance Wire, Form the Heating Unit to Start the Food Cooking. Don't Let Any of the Cork Get in Contact with the Heater Wire.

is operated by electricity. The one that I am going to describe can be built very cheaply, for the material used in its construction is found in almost every home.

The cabinet is made of wood 16x16x18 (quarter-sawed oak ½ in. thick is the best). The inside is lined with about ¼ inch asbestos sheeting. Two ordinary house bricks are each wrapt with several feet of No. 26 Nichrome resistance wire. These two bricks are then covered with asbestos and put in the bottom of the cabinet. From one end of Nichrome wire on brick (b^1), a copper wire is connected by twisting (not soldered). This wire is connected to one terminal of switch (A). The other terminal of the switch is connected to one of the flexible wires. The other wire (P) is connected to the other end of the resistance wire. Another sheet of asbestos is placed over the brick. On top of this a large tin bucket is placed, after being covered by asbestos sheeting on the outside. (A lard bucket is very good.) The space between the bucket and the cabinet is now to be filled with ground cork, such as grapes are packed in. This is clearly understood by looking at sketch. Next put a cover over this so that the only thing you will be able to see is the inside of the bucket. A thick lid is now made for the cabinet with a catch at the front to keep it tightly closed. When you want to cook something, place it in a pot that will fit in the bucket. Turn the current on by switch (A). This will make the bricks hot. These bricks will give off heat for a great while, thus saving current and money.

Contributed by CHARLES FENSKY.

EXHAUSTING BULBS BY MEANS OF LIQUID AIR.

Those who are intending to take up research work as their career, will find immense value in the study of vacuum tubes as used in electrical science, especially in the radio art.

The great difficulty encountered with such devices is the production of sufficiently high vacua in the vessels and the necessity of expensive apparatus for this purpose, which naturally prohibits the average individual from investigating the above-named contrivances.

Liquid air has played an important rôle in the past for the production of extremely high vacua in bulbs and it has been found that it can be used with great ease for this purpose. The following directions will prove of value to the amateur scientist who desires to delve into the great mysteries offered by the investigation of vacuum tube phenomena.

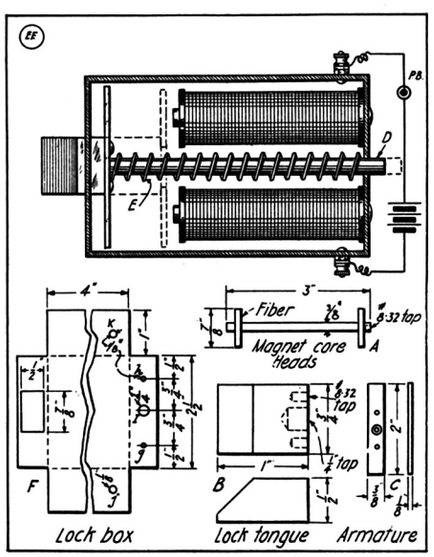
The vessel to be exhausted is filled with a gas which may be more easily condensed than air; as carbonic acid gas. The vessel is provided with an extension tip which can be sealed off very readily. The open end of the extension is then immersed in liquid air, when the carbonic acid is withdrawn from the vessel and deposited in the extension; this is then sealed off, leaving a high vacuum in the vessel.

Precaution should be exercised when pouring the liquid air, as a drop of this liquid when in contact with the human skin will produce a severe burn which is difficult to heal. It is advisable to siphon the liquid from the container into the vessel which is to be exhausted. Carbonic acid gas is inflammable and care should be taken to keep any lighted matches away from the container when such experiments are conducted.

Contributed by SAMUEL COHEN.

HOME-MADE ELECTRIC LOCK.

A cheap and efficient electric lock can be made easily if the following plans are followed. The drawing speaks for itself, but a few words may be necessary. The lock box F, is made from a piece of sheet iron, 6" long by 4½" wide, cut as shown in the figure. It is then bent to form a box. A square hole is cut in the center of one end and 2 ⅛" holes, ½" from each



An Electric Lock Presents Many Advantages Over the Ordinary Mechanical Type. The Control Button May Be Placed in a Secret Location.

side. The two electro-magnets are made as follows:—two pieces of iron rod ⅜" in diameter and 3" long are tapt on one end for No. 8-32 machine screws. A fiber washer ⅞" in diameter is put on each end and the bobbin wound full with No. 18 cotton covered magnet wire. A piece of brass 1" long, ¾" wide and ½" thick is filed to the shape shown in Fig. B, and in one end a ¼" hole is tapt in the center, and 2 holes on either side are tapt for No. 8-32 screws. The armature as shown in Fig. C, is made from a piece of iron ⅛" thick and 2" long by ⅜" wide. Three holes are drilled in it to correspond with the piece of brass in Fig. B. A piece of brass rod ¼" in diameter and 4½" long is threaded for ¼" on one end. A length of brass spring wire is then wound around the rod. The lock is now ready to be assembled. First put the magnets in place with 8-32" screws, and connect the two inside wires together and the two outside wires to the two binding posts on the sides. Then assemble the other parts as shown in Fig. G. Connect it in series with a push button and batteries, and when the circuit is closed the electro-magnets will attract the iron armature C, thereby releasing the lock.

Contributed by L. E. SUMMERTON.

READING VOLTS AND AMPERES WITH THE SAME METER.

A volt and an ammeter are usually mounted on the experimenter's switchboard. Too often those meters have made a considerable dent in the amateur electrician's pocketbook and absorbed money that would be used for purchasing other necessities. What then is required is a method for reading both volts and amperes on the same scale without changing the meter itself in any way.

A common voltmeter will read amperes on the same scale if shunted by a resistance of one ohm. It is only necessary to wire the instrument to the circuit as shown in the illustration, Fig. 1. Throwing the switch up gives ampere readings and down gives the voltage.

That this is true can be proved by Ohm's law. Given a resistance of one ohm it is clear that a current of one ampere will flow under a pressure of one volt. Therefore when the voltmeter indicates a drop of one volt across the one ohm resistance it is plain that one ampere is flowing thru the resistance. Should the meter show a drop of ten volts across the coil, then according to Ohm's law, ten amperes will be flowing. The voltage drop then shows directly the amperes in the circuit.

By changing the resistance of the coil it is possible to vary the range of the instrument. For instance should a coil of one/half ohm be shunted across the meter the reading will be one/half the actual current flow, thus when the meter reads 10 the actual amperes are 20. In other words

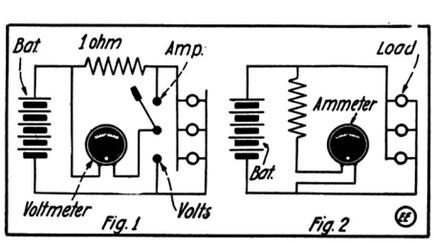
$$C = \frac{E}{R}.$$

Conversely it is possible to read the voltage with an ammeter by connecting as in Fig. 2. In this case the resistance is connected in series with the meter. The principle being again based on Ohm's law which states that the voltage is equal to the resistance multiplied by the current; or $E = R \times C$.

Say for instance that the coil has a resistance of 10 ohms and the meter reads 5 amperes. By multipling these together we get 50 showing that the voltage applied is 50 volts.

It should be remembered that the resistance used should be heavy enough to carry the current without undue heating. Furthermore it is advisable to use a resistance wire that has practically no temperature coefficient such as "Thurlo" wire, thus doing away with the errors that would be present due to changes of resistance when the wire is heated by the current.

Contributed by THOS. W. BENSON.



It Isn't the Instruments You Have; It's the Way You Use Them. By the Application of Ohm's Law, It Is Possible to Read Volts with an Ammeter or Amperes with a Voltmeter.

A D. C. Step-Down Rheostat, Toaster and Stove

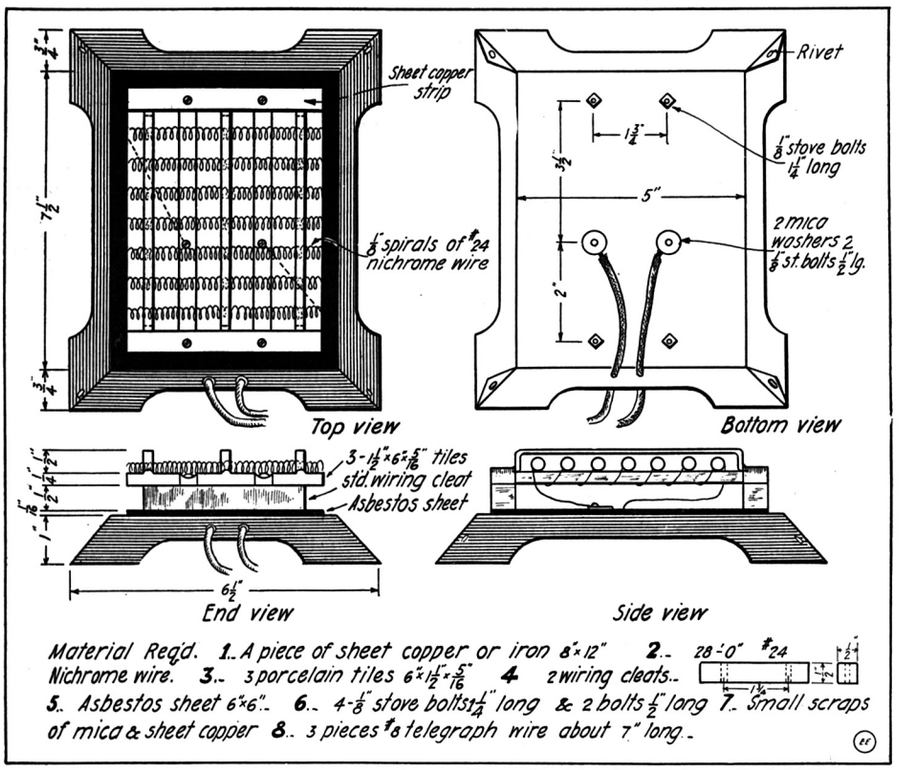
By W. R. WAY

First we have to cut a piece of copper or tin to the rectangular shape, size 10" x 7½". One inch was then marked off from the edges all the way around, the corners cut and then the edges bent down to an angle of 45 degrees approximately, to form a bevel edge. The corners were fastened by means of small tacks or rivets clinched on one side. Cuts were taken out of the bevel edges to improve the appearance and decrease the weight of the base. Having done this six ¼" holes were drilled in the top of the base at their correct distances apart as shown in the sketch. All sharp edges were either bent over or filed smooth. The base may now be considered as finished.

A sheet of 6 x 6" asbestos board 1/16" thick was then laid on the base, and the cleats placed over this and in line with their respective holes in the base top. A ½" wide strip of copper, 12" long, was laid on top of each tile (slate or asbestos board will serve) and holes drilled to suit holes in cleat. The porcelain tiles were placed in position, the strip of copper placed over them on each cord, and 2⅛" stove bolts 1¼" long, were used to bring the two strips together and bind the cleats and tiles to the base securely.

The heating element consists of 28 feet of No. 24 Nichrome wire. This was wound on a ⅛" steel rod in spirals of 6" length and a single wire 6" long left between each spiral. Approximately seven spirals could be made out of this length of wire. When the wire has been formed, it is wound around the tiles, the coils being placed on top and the single wires underneath the tiles so as not to lose heat downwards and heat the base unduly. The ends of the wire were connected to two terminals, having mica washers, and thence thru a cord and plug to the 110-volt lighting circuit. The toaster was then complete.

Besides being an excellent toaster, the device makes a good electric stove or heater, or it may be used as either a rheostat, potentiometer, or resistance for controlling the current input and speed of small electric motors and toys. The toaster draws about 2.25 amps., on the D.C. lighting circuit, and I successfully operated a 1/16 H.P. 27-volt D.C. series motor in series with the toaster. It is made of materials (except perhaps the wire) which nearly any experimenter could easily find lying around the house, and is very easily constructed.


Sheet copper strip
Rivet
1" stove bolts 1¼" long
5"
2 mica washers 2 6" st. bolts ½" lg.
⅛" spirals of #24 nichrome wire
Top view
Bottom view
3-1½"x6"x5/16" tiles
std. wiring cleat
Asbestos sheet
End view
Side view
Material Reqd. 1.. A piece of sheet copper or iron 6"x12" 2.. 28'-0" #24 Nichrome wire. 3.. 3 porcelain tiles 6"x1½"x5/16" 4 2 wiring cleats.. 5.. Asbestos sheet 6"x6".. 6.. 4-⅛" stove bolts 1¼" long & 2 bolts ½" long 7.. Small scraps of mica & sheet copper 8.. 3 pieces #8 telegraph wire about 7" long..

The Combination Electric Toaster and Stove Here Illustrated and Described Will Prove Very Useful, Now That Cool Weather Is with Us Again.

INDIA INK REMOVER.

I think a notice in your magazine to the effect that India ink can be completely cleaned from tracing cloth, would be of interest to your readers. It is claimed that it leaves no trace of the ink and does not injure the cloth. This article is sold and manufactured under the trade name "RASINDIA" and is guaranteed.

Cont. by W. L. FETHERSTON.

HOW A DEAF MUTE ANSWERS HIS DOOR BELL.

Did it ever occur to you how a person who is totally deaf, and living in a house all by himself with his wife, who is also deaf, could answer his door bell?

Probably there have been many schemes devised so that a deaf man might know when his door bell rung. Many of these unfortunates depend on their faithful dogs.

The author has a very fine dog, who can be relied upon all the time, but Nature did not intend that he should remain indoors all the time. Whenever the dog is outdoors for his daily exercise, the door bell proposition presents a difficult problem.

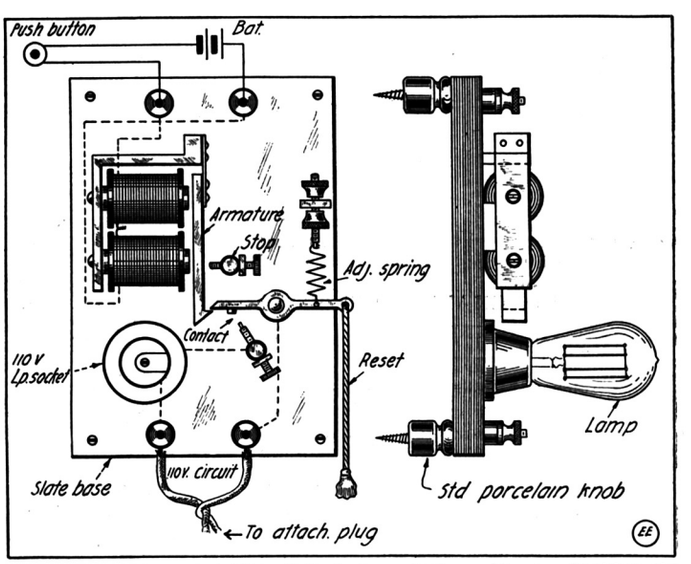
The deaf man, having a keen bent for electrical novelties, designed an electrical system by which the push button would turn on a 40-watt Mazda lamp in the house which would light up a room; this lighting up of the lamp is quickly noticed by the deaf couple's sensitive eyes, the lighted lamp being a signal indicating that some one is at the door. This lamp will burn continuously till the call is answered.

The details and wiring diagram of the device are given herewith. The details of the signal system are as follows: When the push button is closed, the battery circuit is closed, energizing a pair of electromagnets which attract a special form of armature. This armature has a trigger on its end, and on its travel toward the poles of the magnets releases a spring lever. This lever falls toward a stop which serves as a contact, closing a secondary circuit which operates a 40-watt, 110-volt Mazda lamp. The spring lever remains closed; then when the battery circuit is opened again, the armature trigger moves away from the magnets. By pulling down gently the reset chain cord secured to the extreme end of the pivoted contact lever, it is brought upward, passing the latch of the trigger and now rests on the top part of the trigger. In resetting this way, the lamp is turned off automatically, and the next time the push button is worked the whole operation goes on all over again. This device has been in use since last February, and is serving its purpose very admirably.

The regular door bell is disconnected, as there is no need for it in this house. The dog is able to give his customary warning by the slightest noise of the magnetic pull and click of the contact lever.

This man is working on an electrical device at present to wake him up in the mornings, since alarm clock gongs are useless to him.

Contributed by the deaf man himself—
K. B. AYERS.



A Deaf Man Invented This "Flash-Lamp" Door Alarm. Pushing the Button Causes the Bell Magnets to Trip the 110 Volt Lamp Switch. It Is Reset by Hand After Each Alarm.

Chemical Action of Storage Batteries

By ALBERT W. WILSDON

(Concluded)

IF the current is kept constant and the value of V is measured at short intervals, the charge and discharge curves obtained are of the form shown in Fig. 3. The value of V rises rapidly in the first few minutes of the charge from 2.0 to 2.1 volts, and during the rest of the charge continues to rise slowly, until at the end it suddenly rises to 2.5 to 2.7 volts. During this period of rapid rise in the value of V, the cells begin to evolve gas, after which the value of V changes only slightly. On allowing the battery to stand on open circuit for several hours, the electromotive-force E falls to the value corresponding to the density of the

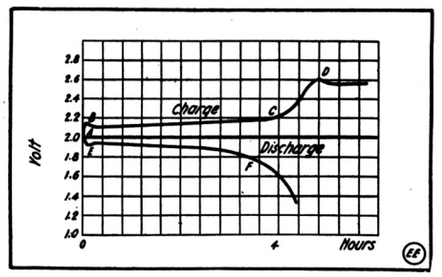


Fig. 3.—Curves Showing Change in Lead Storage Cell Potential on Charge and Discharge.

acid. If the battery is then allowed to discharge with the same constant value of the current as used in charging, the value of V^1 at first falls rapidly to 1.9 volts and then gradually to 1.85 volts, after which it decreases more rapidly to zero. The curves given in Fig. 3 were obtained with about 20 per cent acid and a current density of about 0.005 ampere per square centimeter of electrode surface. With a greater current density the distance between the charge and discharge curves would increase. The general character of the curves for different makes of batteries is the same, tho for those having a thin layer of active material the curves are more marked, and for those having a thick layer, they are more rounded.

From the fact that the charging potential V is several tenths of a volt higher than the discharging potential V^1, as is shown in Fig. 3, it is evident that there is a *loss* of from 20 to 30 per cent. in the energy stored. It might seem at first sight that it results from the loss of energy due to the resistance of the cell itself, to the IR value in equations 20 and 21, but the value of the resistance of the cell is too small to account for such a large loss. On open circuit the resistance of the smallest cells used is only several hundredths of an ohm, and no large increase in its value takes place when a current is passing. The cause of this loss in energy is the polarization of the electrodes caused by the change in concentration of the acid in the pores of the plates. On charging, acid is formed in the pores of the plates where it becomes more concentrated than in the rest of the battery on account of the fact that diffusion does not take place with sufficient rapidity to equalize it. Since the electromotive force of the battery increases with the concentration of the acid surrounding the plates, a higher imprest electromotive force will therefore be necessary in charging. On discharge, the acid is used up in the plates and becomes more dilute than in the rest of the battery, and the voltage falls correspondingly. The charge and discharge curves of the lead battery may now be taken up in detail.

The Charging Curve

On closing the charging current, sulfuric acid is immediately set free at both electrodes and the electromotive-force therefore rises rapidly, as shown by the portion of the curve AB. The rate of diffusion increases with the difference in concentration of the acid on the plates and in the rest of the battery, and when concentration difference has become so great that the rate of diffusion and of formation are equal, this rapid increase ceases. The maximum point at B is probably due to the destruction of the thin continuous layer of sulfate which forms on the electrodes during rest, thus reducing the resistance of the cell. The slow regular rise to C is due to the gradual increase in the density of the acid and also to the deeper penetration of the current lines into the active mass and the corresponding greater difficulty in equalizing the acid concentration by diffusion. The final rise CD takes place when all of the lead sulfate on the surface of the plates has been used up, and consequently the sulfate does not dissolve rapidly enough to replace that electrolyzed out. Very soon the lead solution becomes so dilute that the work necessary to deposit lead is equal to that required to produce hydrogen on the cathode and oxygen on the anode. If allowed to stand on open-circuit, sulfate diffuses from within the plate and brings back the electromotive-force to the normal amount. The maximum point at D is due to the mixing of the concentrated acid in the electrodes with that outside by the gas bubbles.

The Discharge Curve

In discharge the acid is used up in immediate proximity to the electrodes, and this continues until the concentration difference between the acid on immediate proximity to the electrodes and in the rest of the battery has become so great that diffusion just supplies the quantity used up. During this time the value of V^1 falls rapidly along AE. The minimum point at E is possibly caused by the formation of a supersaturated lead sulfate solution. The solubility of lead sulfate in a 20 per cent solution of sulfuric acid decreases with decreasing concentration, so that at the beginning of the discharge, when little solid sulfate is present, a supersaturation of short duration is probable, and the electromotive-force of the battery decreases with increasing concentration of the lead ions. The subsequent gradual fall in the value of V^1 represented by EF is due to the gradual decrease in the density of the acid in the entire accumulator, but more especially to the greater difficulty in the acid diffusing deeper into the plate as the current penetrates deeper. Finally the rate at which the acid diffuses cannot supply the acid used up by the action of the current, and the value of V^1 falls off rapidly.

According to this explanation, the loss in energy on charge and discharge is due entirely to the concentration changes that take place in the electrolyte within the active mass. The smaller these concentration changes are, the more nearly will the accumulator approach *complete reversibility*. This is illustrated in Fig. 4. These curves were obtained with an accumulator of 200 ampere-hours capacity. It is seen that for a current of 0.1 ampere, corresponding to a current density of 0.0017 ampere per square decimeter, the charging and discharging potential differ by only 0.006 volt, or 0.3 per cent of the electromotive force of the cell, and that by reducing the current this loss may be still further reduced.

This loss is not distributed equally between the two plates. The porosity of the lead plate made from the same sulfate paste as the peroxid is about 1.4 times as great as the peroxid; the potential of the peroxid plate falls off about 1.6 times more than the lead plate for a given change in the concentration of the acid, and finally the concentration change on the peroxid plate is greater than on the lead, because not only is sulfuric acid used up on discharge, but water is also formed. All of those facts tend to make the loss on the peroxid plate greater than on the lead plate. When the positive and negative plates are made of similar frames and paste, and have approx-

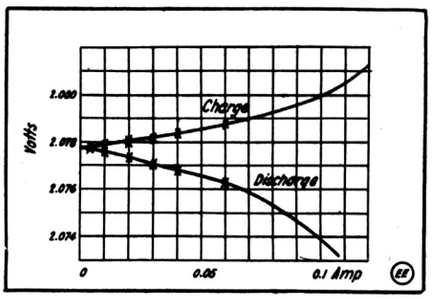


Fig. 4.—Change in Pole Potential of Lead Storage Battery on Charge and Discharge, as a Function of the Current.

imately the same capacity it has been found that 60 to 70 per cent of the loss takes place on the peroxid plate.

The capacity of an accumulator in actual practise means the number of ampere-hours that can be taken from it if discharged at about nine-tenths of its original electromotive-force, the point where the rapid falling off in the electromotive-force takes place. The capacity therefore is determined by the rate of discharge, for the smaller the current the more time the acid has to penetrate by diffusion deeper into the plate, when all of the active material on the surface has been used up. It is also quite evident that the conductivity of the acid will affect the capacity, for the higher the conductivity the deeper will the current lines be able to penetrate into the plate. Since there is a density of sulfuric acid at which there is a *maximum conductivity*, it would be expected that the capacity of a lead storage battery would have a maximum value for this density, and this has been shown experimentally to be the case.

The current efficiency of a lead storage battery, or the ratio of the number of ampere-hours obtainable on *discharge* to the number put into the battery on *charge*, is from 94 to 96 per cent. The small loss of 4 to 6 per cent is due to self-discharge and to the small amount of gassing that cannot be avoided. The energy efficiency, on the other hand, which is the ratio of energy obtainable in the external circuit on the discharge to the energy put into the battery on charge, is only from 75 to 85 per cent. The cause of this comparatively low value, as explained above, is the difference between the charge and discharge potential. The loss in voltage due to the internal resistance is only about 3 per cent with the usual acid concentration and current density. The loss due to polarization is a minimum when the conductivity of the acid in the battery is a maximum, for in that case the lines of current spread over a larger surface by penetrating deeper into the plate.

(*Continued on page* 493)

This department will award the following monthly prizes: First Prize, $3.00; Second Prize, $2.00; Third Prize, $1.00.
The purpose of this department is to stimulate experimenters towards accomplishing new things with old apparatus or old material, and for the most useful, practical and original idea submitted to the Editors of this department, a monthly series of prizes will be awarded. For the best idea submitted a prize of $3.00 is awarded; for the second best idea a $2.00 prize, and for the third best prize of $1.00. The article need not be very elaborate, and rough sketches are sufficient. We will make the mechanical drawings. Use only one side of sheet. Make sketches on separate sheets.

FIRST PRIZE, $3.00

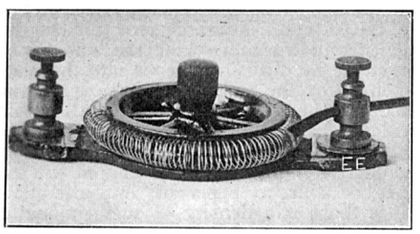
A SMALL INDESTRUCTIBLE RHEOSTAT.

The general construction of the majority of small rheostats does not permit of extremely rough usage, and in some cases is not adapted to the requirements imposed upon this class of instrument. In a word, those with wooden bases are apt to be destroyed by fire, and the ones mounted on porcelain are easily broken.

An instrument constructed after the principle of the one illustrated herewith will be found nearly indestructible. A large iron pulley of the type shown, or a similar form, provides a circular groove, at the perifery of the wheel which is well suited to hold the slightly stretched spiral spring. This spring is of fine steel wire and is insulated from the wheel by a narrow strip of asbestos. The ends of the wire are tied together with asbestos cord, one end being grounded to the wheel; to permit direct electrical base connection.

Any suitable type of handle can be fitted to the wheel to obtain the necessary rotary adjustment. Contacts and connections can be made as desired.

Contributed by R. U. CLARK, 3RD.



An Unusual But Simple Form of Battery Rheostat. It Comprises a Resistance Coil Supported on a Rotatable Grooved Pulley, Against Which a Spring Brush Bears.

ANENT THE "CAPILLARY" GRAVITY CELL.

I read with great interest Mr. Reed's article on "Bats" in the August ELECTRICAL EXPERIMENTER. As a result, I made one of his "capillary" cells. For the capillary cloth I used a piece of old Turkish towel. It worked excellently. But as Mr. Reed says, the internal resistance of the cell is very high.

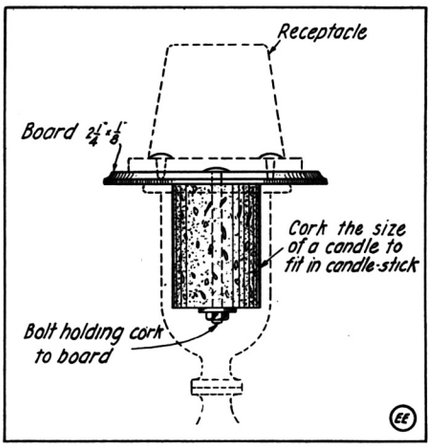
I tested the current of my cell by the loudness of the sound it produced in a telephone receiver. I had four dry cells which I have used for a long time. The capillary cell made a sound not quite as loud as one of these cells. But then I took some common salt, and put some in the solution in the inside cup, in the water outside, and on the capillary cloth. I used enough to saturate the solution. Then I tested my cell, and found that it would produce a sound in the telephone receiver as loud as the four dry cells together connected in series.

Contributed by WM. A. TRIPP.

SECOND PRIZE, $2.00

ELECTRIFYING THE CANDLE-STICK.

Herewith is a drawing of a circular wood base to which a standard lamp socket is



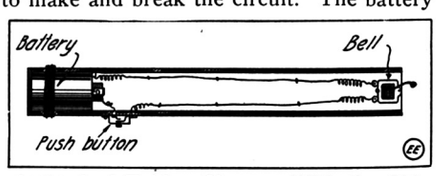
Here's a Simple Way in Which to Electrify Those Handsome Brass or Glass Candle-sticks Which are Seldom Used With Messy Wax Candles.

screwed. The wood base has a cork screwed on to it which fits down in the place intended for a candle in the candle-stick. This little device enables one to make a neat electric candle-stick lamp out of a few odds and ends.

Contributed by JOHN S. STEWART.

A WINDOW TICKER FOR HALLOWE'EN.

A window ticker for Hallowe'en or Thanksgiving can be made with a wooden pole about thirty-six inches long or more and an inch and a half wide. A bell with the gong removed, is screwed on one end and is connected with a flashlight battery on the other end, with a switch or a push-button to make and break the circuit. The battery



Instead of Taking Chances With the Old Spool Window Ticker on Hallowe'en, Use This Simple Electric One on a Long Pole.

is the kind that fits in a pistol flashlight. To use it hold the tapper of the bell near the window and push the button. This kind of ticker is much better than the one operated by a spool with notches in it.

Contributed by THEODORE A. SMITH.

To solder iron use a flux of muriatic acid which has been "cut" with zinc scrap. Don't use this on electric work.

THIRD PRIZE, $1.00

A TOY ELECTRIC STOVE FOR THE KIDDIES.

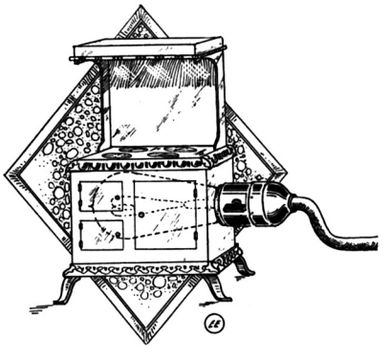
The day of electrical toys that actually work has arrived, as is evidenced by the many practical devices on the market intended to amuse the youngsters.

To fix a toy stove so that it really heats, is not a great problem for those who have access to lighting current. A common 16-C.P. carbon filament lamp mounted in a toy stove will add greatly to its interest retaining qualities.

This can be accomplished very easily. A hole is cut in one side of the stove large enough to pass a key socket. It is soldered in place so the key can be turned. An incandescent lamp with a red bulb is now screwed into the socket and the stove reassembled. It is advisable to make sure the socket is in good condition and not "grounded."

The heat given off by the lamp will not be very great, but the fact that it does heat and the red glow coming from the various parts will bring pleasure to the little "Housekeeper."

Contributed by THOS. W. BENSON.



To Please the Kids Why Not Turn Their Useless Toy Stove Into an Electric one? An Electric Lamp Does the Trick.

REMOVING ACID STAINS.

If first aid is given to acid-stained cloth, one may often remove the stain without taking the trouble to neutralize the acid; the removing agent is merely chloroform. If, however, the cloth has been plainly injured or destroyed by the acid, strong ammonia should first be used to neutralize.

In the case of hydrochloric or sulfuric acid, concentrated ammonia alone will be sufficient. But beware of cheap dyes! Ammonia will turn a pair of black-striped, beach trousers into black trousers. In such a case, chloroform will also remove the running dye.

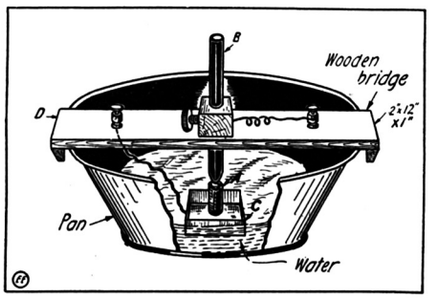
Contributed by J. FIERSTEIN.

Don't forget to send a photograph of your "rinktum" with your description. It makes the article more valuable in every way.

A NOVEL "WATER MICROPHONE."

I give herewith a diagram and description of a very sensitive microphone which is very simple in construction, the entire apparatus being made from a tin pan and an old dry cell carbon.

A lengthy description is unnecessary as its construction can be easily understood by referring to the accompanying diagram,



A Novel Experimental Microphone Made With a Pan of Water and Two Carbon Rod Contacts, One of Which Floats on the Water As Seen.

in which B is the stationary carbon contact, held in position by wooden supports D, and A the loose carbon contact which is slightly dished as shown and supported by wooden float C. The position of the contacts, which is determined by the water level, can be accurately adjusted with a fountain pen dropper.

I have found this instrument to give excellent results using two dry cells. If placed on a table a pin may be dropt near it and heard very distinctly in the 'phones.

Contributed by C. RALPH.

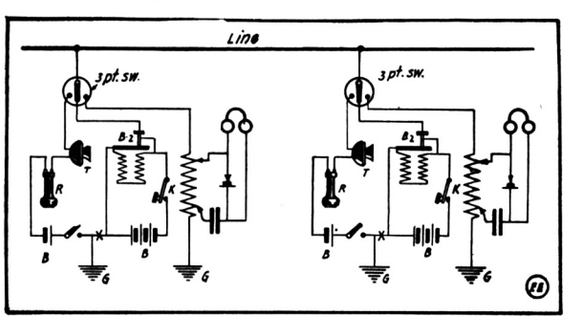
USING A TELEGRAPH LINE FOR TELEPHONE AND WIRELESS.

Very good results have been obtained with circuits indicated in the accompanying drawing.

To talk by telephone close 3 pt. switch on proper point; ordinarily this prevents batteries from running down when not in use. R is the receiver, T the microphone, Sw. the 3-point switch, B the battery cells, G the ground, K the telegraph key and B_2 the buzzer, preferably of the hy-tone type.

This hook-up was used on a line about half a mile long with six stations connected in and it gave the best of results. The buzzer is tuned to give a loud buzz in the station 'phones which can be heard at a good distance from the set. To telegraph over several miles of wire in this way the buzzer currents can be intensified by inserting inductances at X—X; these may be ordinary gas lighting coils costing about $1.50.

Contributed by CHARLES PHILLIPS.



A Clever Scheme Permitting Telephone, Telegraph or Radio Messages to be Transmitted and Received Over a Telegraph or Lighting Circuit.

HOW TO MARK YOUR NAME ON TOOLS.

There are many tools used by mechanics that are so delicate in construction, that it would ruin them if they were marked with the names or initials of the owner put on in the usual way by means of a steel stamp; as many are sprung or thrown out of adjustment, which renders them useless for accurate work. By the chemical method, names or initials may be placed upon tools, etc., without any risk of their being damaged. The corrodent employed does not injure the hands, nor does it wear off the metal; while the solution is cheap and easily applied. The formula is as follows:

Distilled water.....	4 ounces.
Copper Sulfate.....	1 ounce.
Salt	1 "
Zinc Sulfate.....	½ "
Alum Sulfate.....	¼ "

Mix all the chemicals in the water and shake vigorously until they are dissolved. The mixture is then ready to use. Now take the articles to be marked; clean the rust off of the metal with fine sand paper or emery cloth on the spot where the lettering is to be placed. Smear the spot with good soap; then write down the name with a scriber or other sharp instrument, and cover the marking with the fluid—or better still; fill up the tracing with it.

Leave the object alone until the name has turned copper-colored. Moisten the soap with water and rub it off. The solution need only be left on the writing five minutes. The mixture is to be used only on iron or steel goods. To those who would like to have their names put on tools in a neater manner than is possible by the use of a scriber; the use of rubber type, which can be bought in a 10-cent store, is recommended.

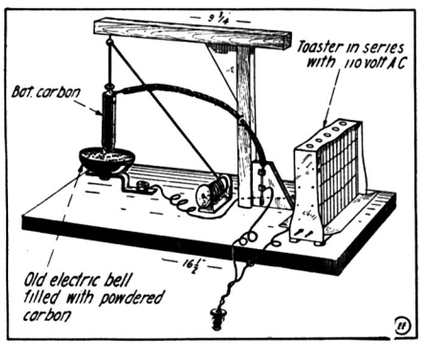
In using these, proceed as follows: Set the type in the holder in the reverse direction to what it will appear when printed; or in other words, reading from right to left. Purchase a small can of asphaltum varnish from a hardware store. Also tack a piece of cotton cloth to a level piece of wood. Spread a small amount of the varnish by means of a flat stick, on the cloth; press the type on the varnish, then press it lightly on the metal and let dry. Make a small rectangular piece of wood about ⅛ of an inch thick, the length and width depending upon the size of the tool and name; the object being to have as wide margins as possible around the name.

Bevel the sides of the rectangular piece of wood with a knife or file—a steep angle making it withdraw easily from the soap. Put a tack in the middle of the piece of wood to serve as a handle. Lay the rectangular piece of wood over the name, making sure that the margins are equally spaced; then put soap or putty around the sides of the wood so that none of the solution will escape. Withdraw the wood, and fill the place with the corrodent. After five minutes, pour the latter off; clear away the soap as previously described and you will have the name in black letters on a copper-colored background. The type should be cleaned after using, turpentine removing the varnish easily. In inking the type with asphaltum, care must be taken not to get too much on, as it will clog the letters. If the type should have too much ink on it, the surplus can be gotten rid of by pressing it on a piece of paper. It would be better for the beginner to try the process on a piece of iron or steel before putting his name on the tool; thus he will become familiar in handling the type and do a good job. These directions for doing the work sound formidable; but it will be found in practise, that it is a very easy matter to place names on tools.

Contributed by W. S. STANDIFORD.

EXPERIMENTAL ELECTRICAL FURNACE.

The drawing in this article shows a small electric furnace which I have constructed in my shop recently. It has given excellent results and I think it will interest numerous other amateur electricians.



Here is a Handy Small-Sized Electric Furnace Which Will Weld Almost Anything.

The furnace is very simple in construction; the drawing will explain everything.

To operate it one has but to lower the carbon into the pot of carbon dust and then gradually raise it again. A white flame plays back and forth from the carbon to the dust, and by inserting a piece of metal in the cup it is quickly fused. The carbon dust may be obtained by filing or grinding a battery carbon.

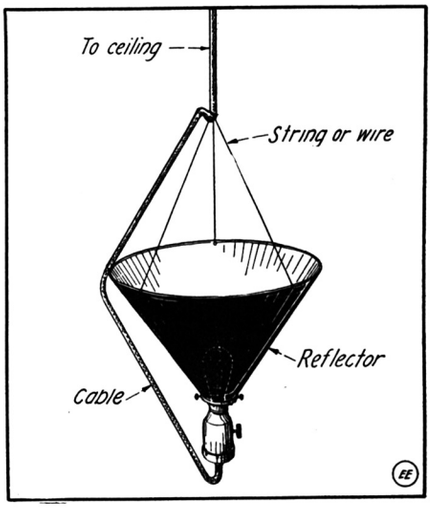
This can also be used as an arc light.

Contributed by STANLEY PENBERTHY.

A GOOD INDIRECT LIGHT MADE IN TEN MINUTES.

Experimenters who have access to electric light in their homes, may enjoy an indirect light by means of an ordinary tin reflector and socket.

Three ⅛" holes should be drilled at angles of 120 degrees apart, around the rim of the reflector. Three one foot lengths of twine or wire should be cut; knot them at one end, and attach the other ends to the holes. Loop the cable and



Do You Want an Indirect Lighting Fixture? Here's a Simple Way to Make One for a Few Cents.

attach the free end of the cord to it, so it will stay upside-down. The inside surface of the reflector should be painted white, using white enamel if possible.

Contributed by CHARLES MASON.

Under this heading we publish every month useful information in Mechanics, Electricity and Chemistry. We shall be pleased, of course, to have our readers send us any recipes, formulas, wrinkles, new ideas, etc., useful to the experimenter, which will be duly paid for, upon publication, if acceptable.

MISCELLANEOUS FORMULAS FOR THE AMATEUR CRAFTSMAN.

No. 1.—Black stain for wood: The intense black color that cabinetmakers produce is obtained by moistening the wood with dilute sulfuric acid and afterwards gently heating. The following mixture answers well. Sulfuric acid, one ounce, water, 8 ounces. When cold add sugar in the proportion of 1 ounce to ten fluid ounces.

No. 2.—Violet Ink: Primula Violet, 1⅙ ounce. Distilled boiled water, 3 quarts. This can be converted into copying ink by adding 4 ounces glycerin.

Primula violet is known as Hoffmans violet. The finest shade is No. 6. Other shades can be made from other colors. Add about 5% alcohol and 1 to 4% glycerin to keep.

No. 3.—Bronzing Copper: Castor oil, 20 parts; Alcohol, 80 parts; Soft soap, 40 parts; water. 40 parts. After copper has been scoured, cover with the above mixture until the desired color is obtained. Then dry in hot sawdust and coat with dilute varnish.

No. 4.—Blue Ink for use on glass: A blue fluid for writing on glass which is not attacked by water is made as follows: Bleached Shellac, 10 parts; Venice Turpentine, 5 parts; Oil of turpentine, 15 parts; Powdered Indigo, 5 parts. Mix the shellac, oil of turpentine, and place in water bath under gentle heat until solution takes place. Then add the indigo.

No. 5.—Sticky Fly Paper: Resin, 1 lb.; Molasses, 3½ ounces. Boil until thick enough.

No. 6.—Stove Polish: Black Lead, 5 parts; Bone Black, 5 parts; Iron Sulfate, 10 parts. Mix thoroly and make into a paste with water.

No. 7.—Hektograph: Gelatin, 1 part; Glycerin, 4 parts; Water, 2 parts.

No. 1.—Ink for same: Methyl Violet, 1 part; Water, 7 parts; Alcohol, 1 part.

No. 2.—Rosaline, 2 parts; Water, 10 parts; Alcohol, 1 part.

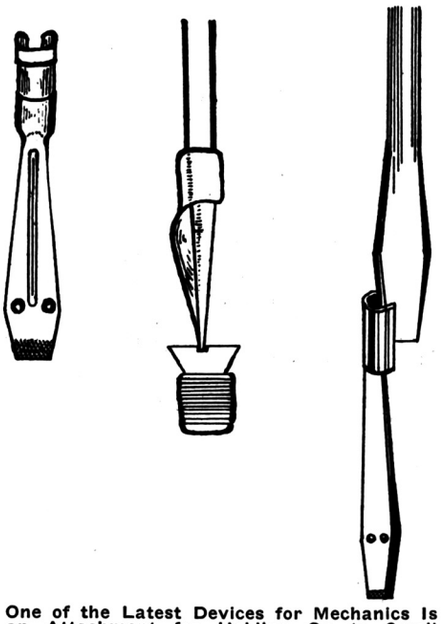
No. 8.—Solder for aluminum: Consists of zinc, tin, aluminum phosphorus. The first two containing the bulk of the alloy. This solder can be used either with the blow pipe or the iron. If the former is used a little silver can be added to it without making it melt and giving it a better color. The surfaces to be soldered are first scraped clean then tinned with the solder itself, no flux being needed. Silver, 2%; Aluminum Phosphorus, 9%; Tin, 34%; Zinc, 50%.

No. 9.—Liquid Glue: Chloral Hydrat, 250 grams; Gelatin, 400 grams; Water, 1,000 grams. The solution is ready in 48 hours.

Contributed by HOWARD A. CROWL.

HOLDING ON TO THE SCREW.

A clever little device has recently been put on the market which should save the motorist's or electrician's vocabulary of swear words from being overworked. The device is made of specially tempered crucible steel and may be slipt on any screw driver. Once in place it serves to hold a screw firmly on the end of the screw driver till it is well started into its required position.



One of the Latest Devices for Mechanics Is an Attachment for Holding On to Small Screws in Inaccessible Places.

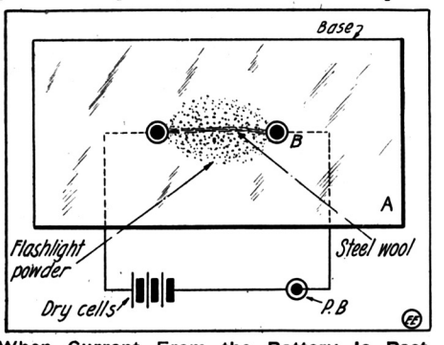
Such a device should prove particularly helpful in fastening parts of machinery which are hard to get at and which require the use of small sizes of screws.—Contributed by ALLEN P. CHILD.

HOW TO SET OFF FLASHLIGHT POWDER.

Very often one wishes to set off flashlight powder when taking an indoor picture, etc. A simple way to set off the powder is shown in the diagram.

A is a small base of slate 2 inches by 3 inches. B two binding posts taken from an old battery. Screw the posts on the base about one inch apart. Procure some fine steel wool from a paint store. Pull out a strand and stretch it between the binding posts. A few dry cells and a push-button are connected as in the diagram.

When a flashlight picture is to be taken pour some powder on the wire and push



When Current From the Battery Is Past Thru the Single Strand of Steel Wool, It Becomes Incandescent; Igniting the Flashlight Powder.

the button. The wire will become red hot and will ignite the powder. A reflector is put behind the base to increase the light.

Contributed by HYMAN R. WALLIN.

THERMOMETER SCALES.

Of the three scales in general use, the Centigrade scale [also called Celsius] is the most rational one and the one used in all scientific research and international literature; it is also used exclusively in most of the European countries. The zero point is the melting point of ice, and the 100° point is the boiling point of water. The Fahrenheit scale is used in the United States and England; on this scale the melting point of ice is exactly 32°, and the boiling point of water is 212°. The Reaumur scale is in limited use in Germany; it has the same zero point as the Centigrade scale, but the boiling point of water on this scale is exactly 80°.

TABLE SHOWING THE COMPARISON OF THE READINGS OF THERMOMETERS.

C = Centigrade, or Celsius. R = Reaumur. F = Fahrenheit.

C	R	F	C	R	F
— 30	— 24.0	— 22.0	23	18.4	73.4
— 25	— 20.0	— 13.0	24	19.2	75.2
— 20	— 16.0	— 4.0	25	20.0	77.0
— 15	— 12.0	+ 5.0	26	20.8	78.8
— 10	— 8.0	14.0	27	21.6	80.6
— 5	— 4.0	23.0	28	22.4	82.4
— 4	— 3.2	24.8	29	23.6	84.2
— 3	— 2.4	26.6	30	24.0	86.0
— 2	— 1.6	28.4	31	24.8	87.8
— 1	— 0.8	30.2	32	25.6	89.6
Freezing	point	of water	33	26.4	91.4
0	0.0	32.0	34	27.2	93.2
1	0.8	33.8	35	28.0	95.0
2	1.6	35.6	36	28.8	98.8
3	2.4	37.4	37	29.6	98.6
4	3.2	39.2	38	30.4	100.4
5	4.0	41.0	39	31.2	102.2
6	4.8	42.8	40	32.0	104.0
7	5.6	44.6	41	32.8	105.8
8	6.4	46.4	42	33.6	107.6
9	7.2	48.2	43	34.4	109.4
10	8.0	50.0	44	35.2	111.2
11	8.8	51.8	45	36.0	113.0
12	9.6	53.6	50	40.0	122.0
13	10.4	55.4	55	44.0	131.0
14	11.2	57.2	60	48.0	140.0
15	12.0	59.0	65	52.0	149.0
16	12.8	60.8	70	56.0	158.0
17	13.6	62.6	75	60.0	167.0
18	14.4	64.4	80	64.0	176.0
19	15.2	66.2	85	68.0	185.0
20	16.0	68.0	90	72.0	194.0
21	16.8	69.8	95	76.0	203.0
22	17.6	71.6	100	80.0	212.0

Boiling point of water.

To convert *Centigrade* into Fahrenheit:

Degrees Centigrade multiplied by 9, and divided by 5, then add 32.

Example — 80° C. × 9 ÷ 5 = 144 + 32 = 176° F.

To convert *Fahrenheit* into Centigrade:

Subtract 32 from the number of degrees Fahrenheit, then multiply by 5, and divide by 9.

Example — 100° F. — 32 = 68 × 5 ÷ 9 = 37.8° C.

To convert *Reaumur* into Fahrenheit:

Degrees Reaumur multiplied by 9, divide by 4, and add 32.

Example — 16° R. × 9 ÷ 4 = 36 + 32 = 68° F.

To convert *Fahrenheit* into Reaumur:

32 subtracted from degrees Fahrenheit, multiply by 4, and then divide by 9.

Example — 95° F. — 32 = 63 ÷ 9 × 4 = 28° R.

The above table and formula for converting the different degrees to another will be found very useful, especially when, for instance, you have facilities to work with a Centigrade themometer, and the Fahrenheit degree is mentioned.

Contributed by
ALBERT W. WILSDON.

FILLING THE FOUNTAIN PEN WITHOUT DROPPER.

Oftentimes a person finds an occasion to fill a fountain pen, but they have no dropper handy. So here is a little trick to try on your fountain pen. Take a pin or match, and draw a channel out to the edge of the mouth of the ink bottle, with the ink. The ink will follow this channel, and run into the fountain pen, without spilling a drop.

Contributed by HOBSON ARNOLD.

Experimental Chemistry

By ALBERT W. WILSDON

Eighteenth Lesson

Sodium Hydroxid (NaOH) and Potassium Hydroxid (KOH)

HISTORY.

THE word "Alkali" meant originally "Ash," a particular sort containing Sodium Carbonat, and used in glass-making. Two classes of alkalies were early distinguished—the mild alkalies, which are now called alkalin car-

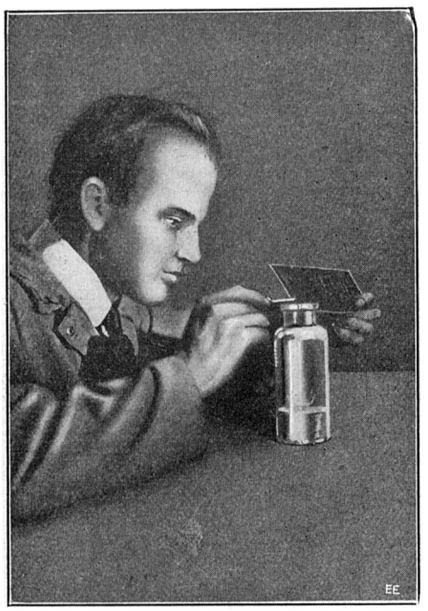


Fig. 89. Interesting Experiment with Sodium and Water. The Lighted Splint or Combustion Test Is Tried After the Sodium Has Been Dropt in the Water.

bonats, as Sodium Carbonat, and the caustic alkalis, as NaOH (sodium Hydroxid). Two divisions of these latter are now made, *i. e.*, the volatile alkali, ammonium hydroxid (NH_4OH), which upon the addition of heat entirely vaporizes, and the fixt alkalis, which leave a solid residue on the evaporation of their solutions. Sodium and potassium hydroxid are two examples of these. With strong heat these vaporize but do not break up, and, until Davy's experiments on them with the aid of the electric current, they were regarded as elements.

In 1736 Duhamel distinguished Sodium hydroxid from potassium hydroxid, previous to which there was no distinction between them, or the salts of sodium and potassium. The latter then became known as "potashes."

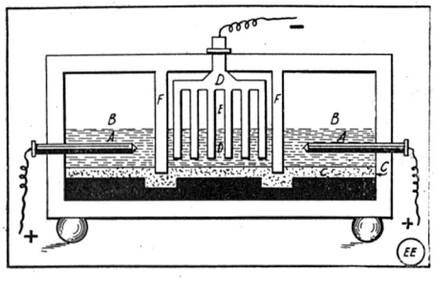


Fig. 88. Diagrammatic View of the Castner-Kellner Process for the Electrolytic Production of Caustic Soda and Caustic Potash.

In 1807 Davy discovered the metal *potassium,* by the electrolysis of potassium hydroxid. Thus by the decomposition of potassium hydroxid by electrolysis it was proved that they were not elements.

OCCURRENCE:—Owing to their strong affinities, neither potassium nor sodium hydroxid are found in the free state. Sodium or Potassium occur very commonly as silicates in granite and other rocks, and in their chlorids (Sodium Chlorid, NaCl, and potassium chlorid, KCl) and in other salts, but never free. Potash (K_2CO_3) is the principal alkali of the animal body, hence the need of potassium in food plants.

PREPARATION:—1. It is conveniently prepared by the interaction of metallic sodium or potassium with water.

$$Na + H_2O = NaOH$$
$$K + H_2O = KOH$$

2. THE ELECTROLYTIC PRODUCTION OF CAUSTIC SODA AND CAUSTIC POTASH:—This will probably be of most interest to readers of this journal, as one of the methods of preparation.

There have been numerous methods and processes invented for the manufacture of the caustic alkalis by electrolysis. Probably the best known method is the *Castner-Kellner process.* This consists of a tank (Fig. 88) which is divided into three compart-

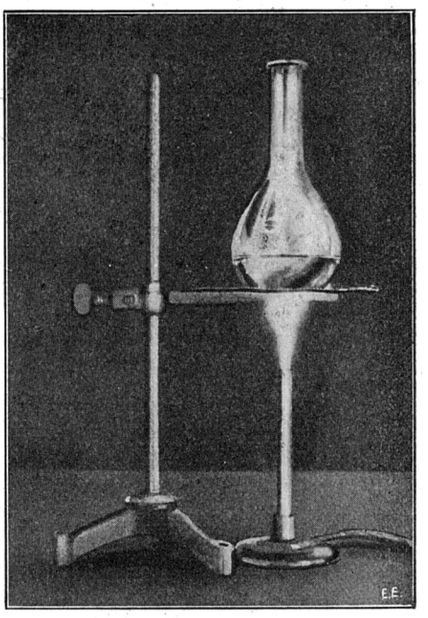


Fig. 91. Experiment No. 101, In Which Sodium Hydroxid Is Produced by Heating a Solution of Water, Slaked Lime and Sodium Carbonat.

ments as shown; the two outside (BB) contain the sodium or potassium brine, and the carbon anodes (+ +); while the centre one (E) contains the iron cathode (D). Thru this inside compartment (E) a continuous supply of water flows, which takes up the caustic soda (or potash) produced and is conducted off into collecting tanks. The partitions (FF) are open below, just reaching to the surface of a layer of mercury (CC) which covers the entire bottom of the tank. The metal (Sodium or potassium) liberated amalgamates at once with the mercury (C), which by the tilting of the whole apparatus up and down, by means of a cam passes into the middle compartment (E), where it acts as the anode during the passage of the current to the iron cathode (D); the metallic sodium (Na) or Potassium (K) of the amalgam is thereby liberated, which reacts with the water present, forming sodium (or potassium) hydroxid, and hydrogen gas which is formed at the negative electrode (—). From the compartments (BB) chlorin passes as a gas to the upper parts, which is then drawn off and utilized for making bleaching powder, hydrochloric acid, etc. The lye obtained from the cathode chamber (E) contains about 20 per cent of caustic

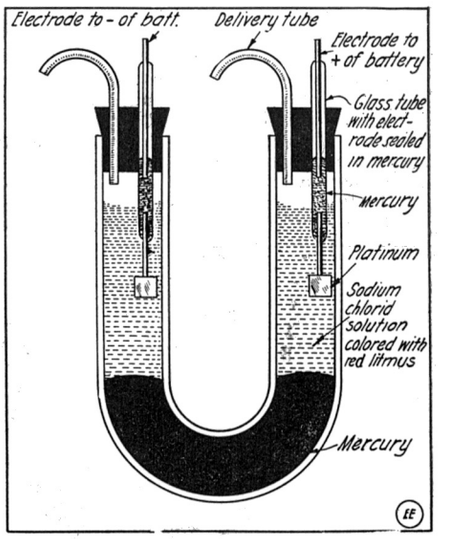


Fig. 92. Home-made Laboratory Apparatus for the Electrolytic Preparation of Sodium Hydroxid. It Is Used in Conjunction with a Battery.

soda or caustic potash, which, after evaporation, yields a product of about 99.5 per cent pure.

3. On the commercial scale sodium hydroxid is produced by a modification of the *LeBlanc process* for preparing sodium car-

(*Continued on page* 494)

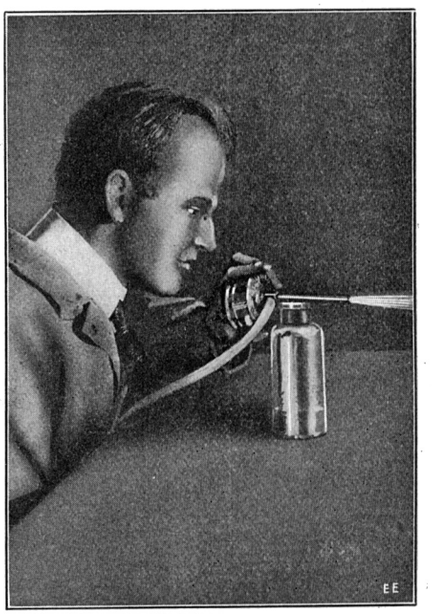


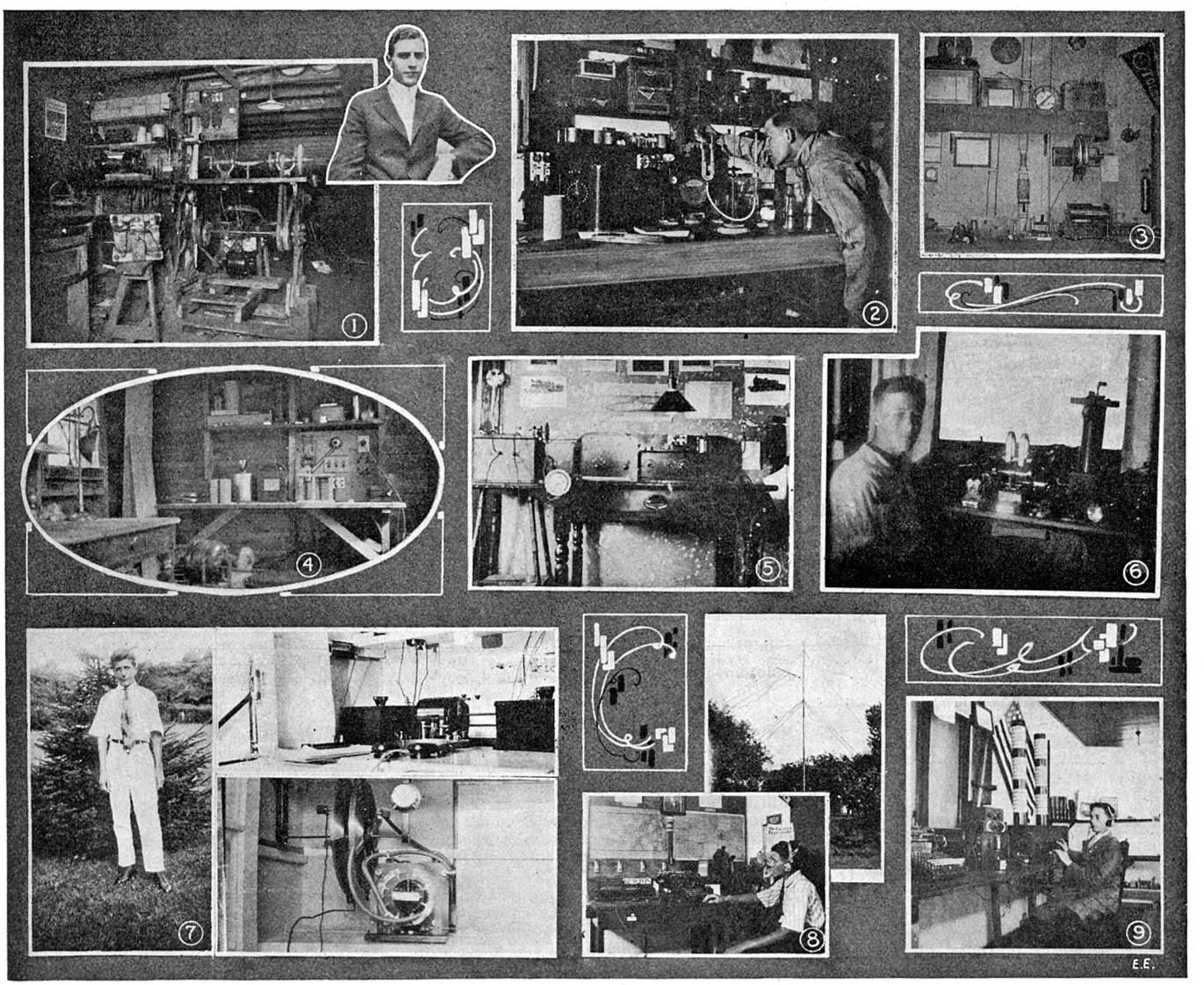
Fig. 90. Another Sodium and Water Experiment—After the Action Stops the Air Orifice of a Bunsen Burner Is Held Over the Bottle, Giving a Yellow Color to the Flame.

WITH THE AMATEURS

Our Amateur Laboratory Contest is open to all readers, whether subscribers or not. The photos are judged for best arrangement and efficiency of the apparatus. To increase the interest of this department we make it a rule not to publish photos of apparatus unaccompanied by that of the owner. Dark photos preferred to light toned ones. We pay each month **$3.00** prize for the best photo. Make your description brief and use only one side of the sheet. Address the Editor, "With the Amateurs" Dept.

At Last Some "Electrical Laboratory" Photos!!!

At last the "Radio-bugs" seem to be waking up. Observe the four Electrical laboratory photos we have with us this month. Now, why is it that we can't receive more photos from "ELECTRICAL LABORATORY" owners, when there are about a million of you scattered thruout the United States at this very moment! As you will remember we made all of you a special offer in the September number, *viz.*, we offered to give not only the $3.00 monthly prize for the best "Electrical Lab." photo, but 5 (five!!!) additional prizes of one year's subscription to this journal, and a copy of the "EXPERIMENTAL ELECTRICITY COURSE" for the best five photos submitted, after awarding the first prize. And all the answers we receive are FOUR photos. After awarding first prize of $3.00 the remaining three have been awarded a year's subscription and a copy of the famous *Experimental Electricity Course*. As we have just said, it is strictly up to you whether you wish to take a chance on winning the $3.00 cash prize, and also if you wish to throw away the chance of receiving "The ELECTRICAL EXPERIMENTER" magazine for one year **free of all cost,** besides the copy of the *Experimental Electricity Course,* which is worth $1.00 alone to my electrical student. Address the Editor "With The Amateur's Prize Contest."



A GROUP OF REPRESENTATIVE AMERICAN AMATEUR LABORATORIES

Electrical Laboratories of, 1—Joseph F. Birchler, St. Louis, Mo. ($3.00 Prize); 2—Thos. W. Benson and Mr. Uphoff, Philadelphia, Pa.; 3—Earl Scottie Ensign, Toledo, O.; 4—James L. Clifford, Evansville, Ind. (Nos. 2 to 4, inclusive, each awarded one year's subscription to the "E. E." and a copy of the "Experimental Electricity Course); Radio Stations of 5—Osmond Ryer, Pasadena, Calif.; 6—Clarence de Witt Rogers, Jr., Larchmont Manor, N. Y.; 7—W. Leathe, Larchmont, N. Y.; 8—Raymond Yoder, Newton, Kansas; 9—James Girand, 6EO, Phoenix, Ariz.

An Exceptional Experimental Laboratory

By GEORGE HOLMES and ALBERT W. WILSDON

THE Editors' very appealing and pathetic "S O S" for electrical and kindred laboratory photographs, was picked up on our short wave regenerative set, and due to the strong regenerative action, we take great pleasure in introducing our laboratories to ELECTRICAL EXPERIMENTER readers together with photos and data.

In obscurity for several years, our endeavors have been constantly branching out, ever since the early stages of the radio babyhood. Our complete laboratory, scientific instruments, periodicals, and various equipment is the outcome of nigh on to ten years accumulation. By this we do not mean that we have preserved all of the apparatus which was made and acquired during this period, but specimens of the early stages of electrical, chemical and radio apparatus have been carefully preserved, and the remainder of the beloved "junk" has been either dismantled or thrown away to make room for modern equipment, which has been proven more efficient than the older types.

Figs. 1 (Upper Left), 2 (Upper Right) and 3 (Bottom View), Illustrating the Excellent Electrical and Chemical Research Laboratory Owned by Two Live-Wire Experimenters. Such a Laboratory Is Something to Be Proud of.

The laboratories cover a space of four rooms which are divided as follows: The first floor contains our office, with up-to-date filing systems, which enables us to instantly refer to any special topic, or any certain piece of intricate apparatus; which by the way, is only one of our novel features. By labeling a certain piece of apparatus with what we call a "key," and putting the data on a filing card, then by reference thereto, valuable time and trouble are saved by this system. Our books, consisting of hundreds of scientific books, periodicals, magazines, patent papers, scrap books containing clippings of interest, and bearing on all scientific subjects, were taken from papers as far back as ten years. The library, with the aid of our filing system, is of great convenience when conducting experiments. Many pleasant winter evenings have been spent in this room, chatting and discussing future and past experiments and research problems.

Above the office is the "Radio" room, Research and Testing room, Photographic dark room, and Chemical Laboratory.

The layout of our Radio room may be of interest to readers who are contemplating overhauling, or reconstructing their sets. On the right hand side of the room are the switchboards, constructed of slate, all the wiring being past thru approved conduit. Fig. (1), shows these switch-boards and a group of relays. Either D. C. or A. C. current, varying from one to two hundred and fifty volts are instantly available, which of course is of great advantage in many experiments. A certain laxity on some of the work prevails owing to the numerous cables which have to be strung temporarily, such as for testing arcs, etc. Fig. (3) shows a partial view of the Radio Apparatus, which is all home-made.

Our radio apparatus is of course now cut off from actual service, in accordance with the proclamation of the President, and a careful scrutiny of the rotary gap and oscillation transformer under the table, discloses the wire sealing it up, upon which we have placed a tag bearing the inscription "Sealed in accordance with President Wilson's Proclamation. Here lies the remains of Pal Wireless, who died a struggling, and sudden death. May his spirit be reincarnated in all the glory of the original." Seems a funny sort of thing to be tagging on a wireless set—don't it? But when we go over the pleasant memories of the incoming signals from Nauen, Sayville, and other high powered stations we feel a lump in our throat, but of course we pass it over (not the lump, but the ban), saying "What has happened, had to happen, and it must be for the best." We sincerely hope that it is for the best, and have in fact, mapt out "some set," incorporating several new features, such as Morecroft inductances. We trust that the reader will pardon us for this lengthy post mortem statement, but we feel certain that like thoughts are creeping into his own mind on glancing over our belated loss.

Well, to get down to brass tacks, the general layout will probably be of interest. Facing the south against the window shown on the extreme right of the Radio "Lot" photo, are the operators' desks, upon which a large square glass plate is placed and under which a map of the important radio stations is located, which we have improved upon by placing the call letters after them; thus enabling us to determine the distance of the station. Under the glass is also placed various station calls and miscellaneous information of importance to the operator. Next to our right hand are the push buttons for the rotary gap, and the radio transmitting key together with keys for the outside telegraph lines, thus permitting us to get in communication at once with the various stations on our lines via telegraph. To the left of the operators' position may be seen the aerial switch, hot wire radiation meter, one step Audion amplifier, damped and un-damped wave receptors, crystal detector, receiving set, also a large loading inductance. The receiving circuits are all connected with Litzendraht and soldered. Three pairs of 'phones are available.

On the extreme left of the photo may be seen a portable sending and receiving set. The portable transmitting set consists of a one inch spark coil with the necessary accessories. The receiving set contains a loose coupler of our own design, variables, loading inductance, and the necessary switches. With this field set we were able to keep in constant touch with the parent station while conducting tests, a great factor which enables us to make accurate measurements, and keep accurate data on hand for future experiments.

Underneath the table is the regular transmitting set, (now "sealed" of course, for the duration of the war) consisting of a 1 K. W. Thordarson transformer and oil condenser, these two being placed in the large cabinet under the table. On the top of the case is the rotary spark gap, and brass ribbon oscillation transformer. All the leads are short and are of flexible copper cable with heavy rubber insulation. The ends being soldered into lugs.

The aerial used consisted of a large 100 ft. iron pipe mast, having short and long wave-length aerials, together with the necessary ground switches. (The aerial is not up at the present writing!) The aerials consisted of 500 feet of phosphor bronze wire for the reception of long and undamped waves, and the second of a 4 wire 80 feet long, adapted to transmitting and receiving on a short wave regenerative set.

On the other side of this room are placed two drafting tables, upon which new apparatus are designed and drafted.

The room directly opposite the radio-room is the laboratory, around the walls of which are placed shelves to hold the various instruments and supplies. A large table in the centre of the room holds the numerous testing devices; such as Wheatstone bridges, wave-meters, decremeters, hot wire meter, volt meters and ammeters.

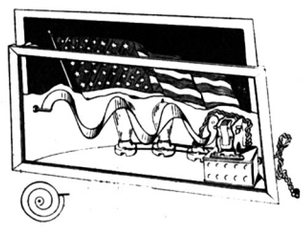
In one corner of the room are located the chemical and testing tables, which permits tests to be made while the experiment is in progress, and in this way we have the advantage of several readings with which we can compute the results. The chemical laboratory is completely equipt, containing all the common reagents and

(*Continued on page* 500)

LATEST PATENTS

Illuminated Display Apparatus.
(No. 1,238,739; issued to Frederick C. Bowdidge and Preston C. McMullen.)

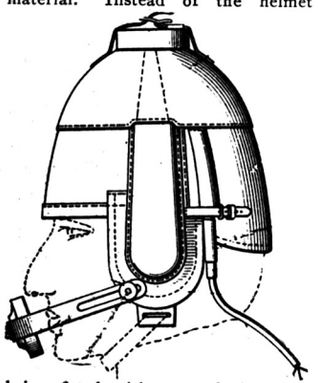
This patent describes a very simple and yet effective device for creating the effect of a waving flag or other moving object. A glass screen in



the front of cabinet shown, has for instance a waving flag painted on the face of it. Back of this screen there are placed several lamps for illumination and in front of this a slowly revolving metal spiral connected to a small electric motor. For best results the space around the flag should be made opaque. The spiral is cut out from a flat piece of metal and afterward expanded to the shape shown in the cabinet.

Telephone Helmet for Aviators
(No. 1,235,851; issued to Jesse Lee Spence.)

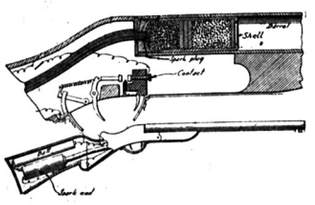
The patentee here provides an improved form of telephone helmet for aviators, the helmet proper being composed of leather or other suitable material. Instead of the helmet



being fitted with two telephone receivers pressing against the ears, use is made of a single telephone receiver mounted at the top of the helmet. This communicates with two sound channels which extend downward on either side of the helmet to the ears. The microphone is adjustably supported on a removable bracket, pivoted on either side of the helmet in the manner shown.

Electrical Gun
(No. 1,239,344; issued to Levi M. Bowman and William A. Smith.)

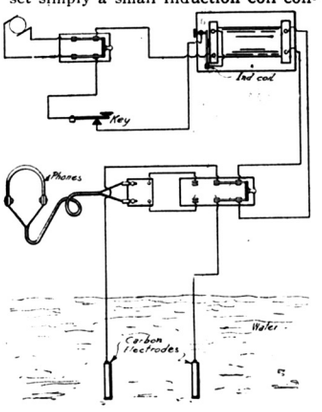
This represents an electrically fired gun which appears to possess several meritorious features. Acci-



dental discharge is prevented, for one thing, and after having once been sighted, the pulling of the trigger to fire the gun will not pull the gun off from the object sighted at. Further, this electrical gun structure includes a special primer or firing cap which carries a sparking point, so that the shell is discharged by the formation of a disruptive spark in the primer. The stock of the gun contains a battery which is connected to a spark coil in the usual manner. The spark coil primary circuit is controlled by the trigger contact.

Underwater Radio Scheme
(No. 1,233,211; issued to Frank P. Fisher and Hugh Dehart.)

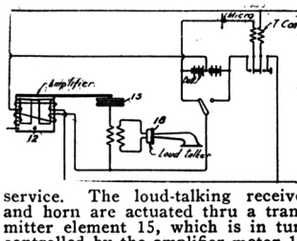
Under-water telegraphy can be carried on by this arrangement over considerable distances it is claimed. The apparatus involved is very simple, comprising for the transmitting set simply a small induction coil con-



nected with a source of power and a signaling key. The secondary leads from the coil are connected to a double pole, double throw switch as shown, so that the receiving set (pair of 'phones) can be switched in when desired. The blades of the switch are connected to two carbon electrodes submerged in the water, a suitable distance apart. It has been found that about 20 feet apart is the proper distance to set the electrodes for an apparatus having a range of 500 to 1,000 feet. It is mentioned that communication can be established with submarines.

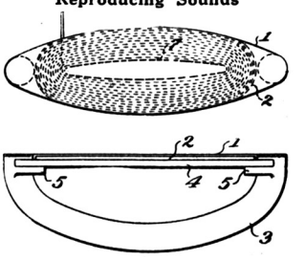
Telephone Amplifier
(No. 1,232,514; issued to Henry C. Egerton.)

This invention relates to amplifier systems for increasing the intensity of telephone currents. It permits several stations similarly equipt and on a common circuit to be supplied with current from one and the same



service. The loud-talking receiver and horn are actuated thru a transmitter element 15, which is in turn controlled by the amplifier motor 12, which is of special construction. It is rendered particularly sensitive to telephonic currents by means of two distinct windings, conected in such relation one with the other, that opposite magnetic polarities are present within each core; therefore a given impulse of current thru the operating windings acts to increase the magnetic pull at one end of the armature, while decreasing the magnetic pull at the other end of the armature, all in a well-known manner. Suitable bearings at the middle pole-piece of the amplifier electro-magnet, permit the armature of this magnet to move reciprocally in a rocking manner in unison with reversals or changes in amplitude of the telephone curent, thereby varying the pressure on the active material of the transmitter element 15.

Telephone for Transmitting and Reproducing Sounds



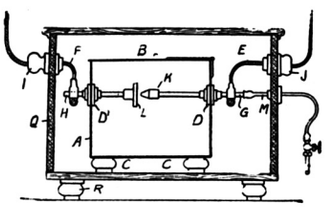
(No. 1,238,439; issued to Rudow Rummler.)

This invention relates to telephones, wherein a diafram and a coil of wire are so arranged that the coil may exert a direct inductive action on the diafram, more or less independently of the permanent magnet, and provides means for magnetically suspending the diafram in a magnetic circuit.

In the construction shown, an electrical diafram 1, of magnetic material, such as soft iron, is placed above the flat, spiral elliptical coil of insulated wire 2, this coil being connected in the usual manner. The permanent magnet is seen at 3.

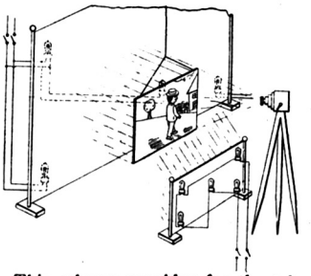
Rectifying Spark Gap for Radio
(No. 1,235,935; issued to Archibald Shaw.)

This design of high tension, high frequency spark gap is one of the



best yet brought out. It employs a fine stream of gas, such as air, under high pressure which is forced out thru the center of the smaller or point electrode of the gap. This stream of air is forced against a relatively large flat disc, and when the primary and secondary circuits to which such a gap are in resonance, no arcing will occur, but the discharge will take the form of a bluish-white incandescent blaze of tapered form, extending across the gap; furthermore a pulsatory discharge having a very high frequency passes in one direction only. It has been found best to employ an air pressure of 110 lb. per sq. in.

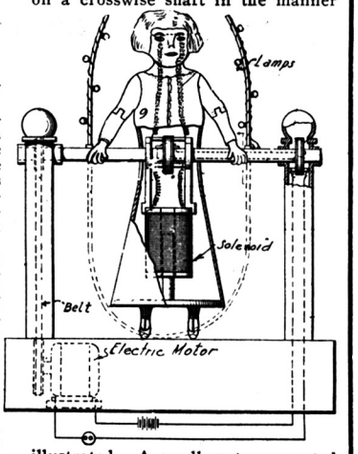
Making Cartoon Movies
No. 1,235,871; issued to Carroll M. Aument.)



This scheme provides for the taking of cartoon motion pictures in a new and improved manner. It represents an advance over other methods in that a permanent background is used instead of a number of them, and the scene is moreover painted or sketched on a properly prepared glass plate. The artist can thus prepare a scene or figures on either side of the glass, and suitable illumination is provided to enable him to do so. Special illuminating screens are employed as shown.

Electric Dancing Doll
(No. 1,238,786; issued by Joseph Kershaw.)

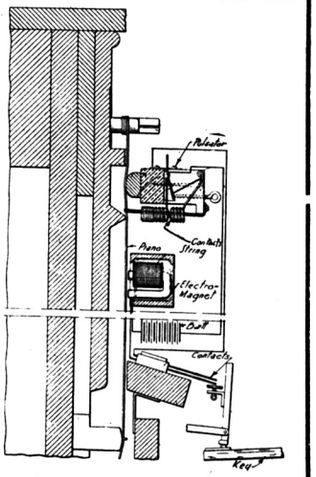
This is a particularly ambitious electrical toy in the form of a miniature metal doll which is supported on a crosswise shaft in the manner



illustrated. A small motor mounted in the base of the toy connects with the revoluble shaft by means of a belt; the motor circuit being periodically made and broken at the proper instants, by the contact disc and brushes carried on one end of the shaft. When the skip rope reaches the downward position, the toy figure is pulled upwards by means of the solenoid concealed in the skirt.

Electrical Piano
(No. 1,233,306; issued to George Breed.)

This is one of the cleverest electrical piano ideas we have seen. The



music strings are supported in the usual manner as indicated. At a point along each string is placed an electro-magnet which starts the string vibrating when its circuit is closed by the key contact shown. Included in this circuit is a special tuned interrupter or pulsator near the top of the string.

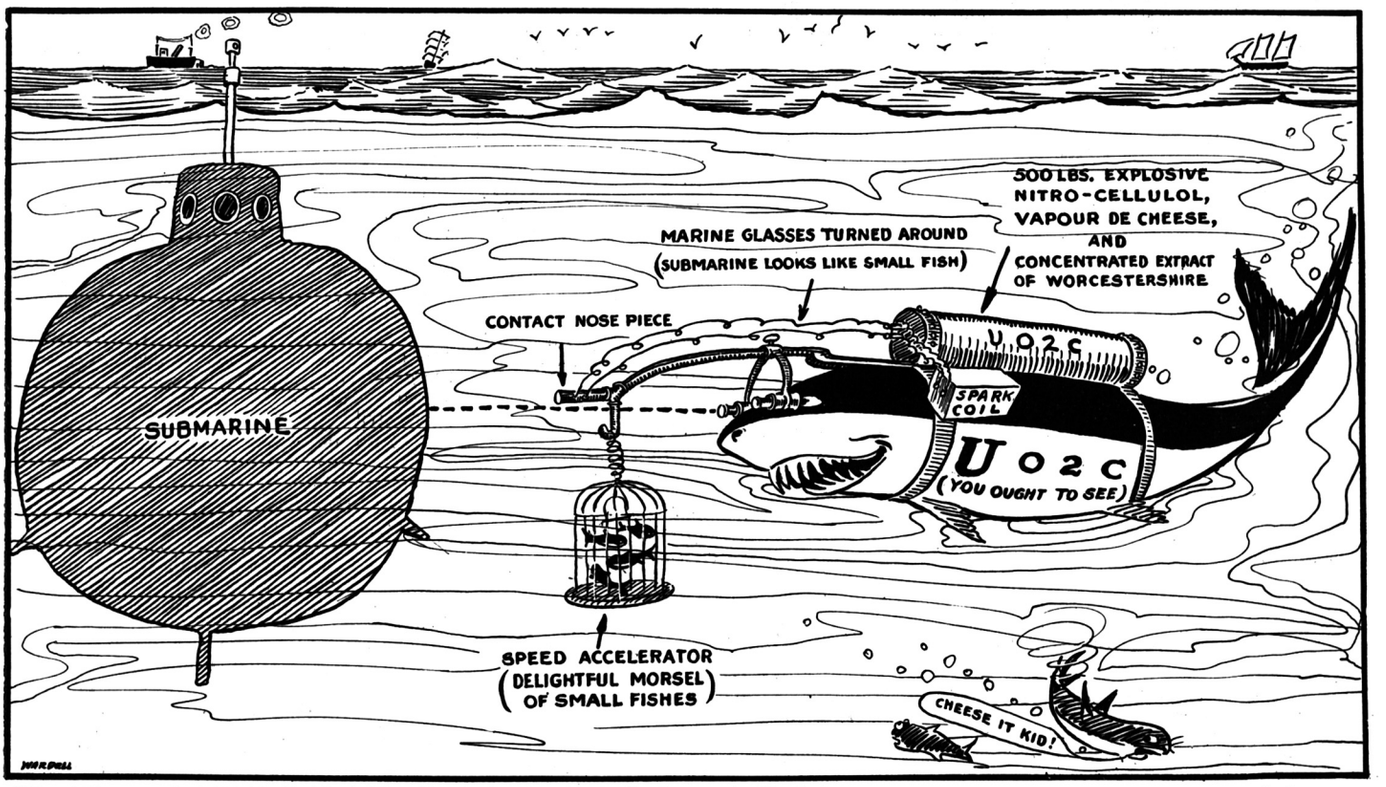
COPIES OF ANY OF THE ABOVE PATENTS SUPPLIED AT 10c EACH.

Phoney Patents

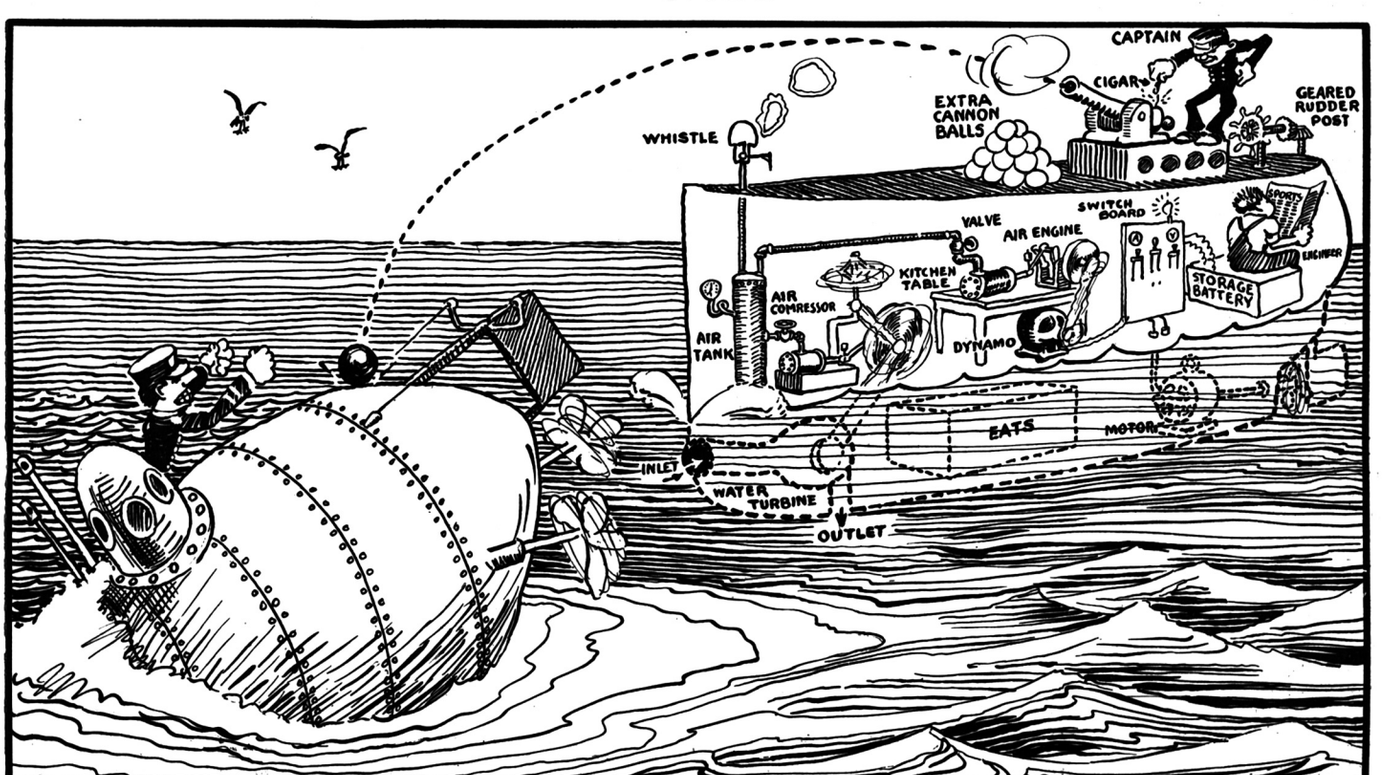
Under this heading are publisht electrical or mechanical ideas which our clever inventors, for reasons best known to themselves, have as yet not patented. We furthermore call attention to our celebrated Phoney Patent Offizz for the relief of all suffering daffy inventors in this country as well as for the entire universe.

We are revolutionizing the Patent business and OFFER YOU THREE DOLLARS ($3.00) FOR THE BEST PATENT. If you take your Phoney Patent to Washington, they charge you $20.00 for the initial fee and then you haven't a smell of the Patent yet. After they have allowed the Patent, you must pay another $20.00 as a final fee. That's $40.00! WE PAY YOU $3.00 and grant you a Phoney Patent in the bargain, so you save $43.00!! When sending in your Phoney Patent application, be sure that it is as daffy as a lovesick bat. The daffier, the better. Simple sketches and a short description will help our staff of Phoney Patent examiners to issue a Phoney Patent on your invention in a jiffy.

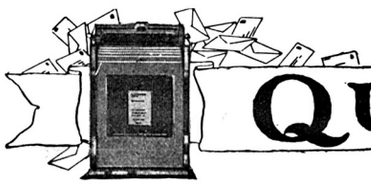
PHONEY PATENT OFFIZZ



Prize Winner. SUBMARINE KILLER. Shark Carries High Explosives in Tank Strapt to His Back. Extension Beam Carries Fish-Bait in Front of His Nose. This Makes Him Speedy Trying to Catch Fish. Inverted Marine Glasses Make Submarine Appear Like Small Fish. He Rushes for It—Contact Nose Piece Operates Spark Coil, Which Blows Up the Tank, Sub., Shark and All. Inventor, John P. Buckley, Washington, D. C.



SELF-PROPELLED BOAT. Water Enters Ship's Bow Thru Inlet, Leaving it by Outlet, Incidentally Driving Water Turbine. The Latter Drives Air Compressor, Which Runs Air Engine and This Drives the Dynamo. The Latter Charges Storage Battery Which Runs Motor. Motor Operates Ship's Propeller, Thus Ship Will Never Run Out of Power. Inventor, Thomas Stewart, Jersey City, N. J.



QUESTION BOX

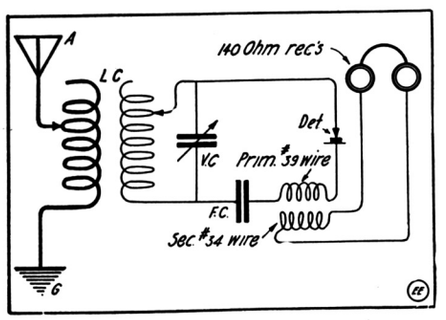
This department is for the sole benefit of all electrical experimenters. Questions will be answered here for the benefit of all, but only matter of sufficient interest will be publisht. Rules under which questions will be answered:

1. **Only three questions can be submitted to be answered.**
2. **Only one side of sheet to be written on; matter must be typewritten or else written in ink, no penciled matter considered.**
3. **Sketches, diagrams, etc., must be on separate sheets. Questions address to this department cannot be answered by mail free of charge.**
4. **If a quick answer is desired by mail, a nominal charge of 25 cents is made for each question. If the questions entail considerable research work or intricate calculations a special rate will be charged. Correspondents will be informed as to the fee before such questions are answered.**

RADIO TELEPHONE RECEIVER TRANSFORMER.

(853.) Willi. ı Reeve, East Boston, Mass., desires dai.. for building a radio telephone receiver tı:nsformer.

A. 1. Relative to data on radio telephone



How Telephone Receiver Transformer Is Connected in Radio Detector Circuit.

receiver transformer we advise as follows:

The annealed iron wire core should be made of small size stock. It may measure ¼ of an inch in diameter by 3 inches long. The primary coil to be connected to the detector circuit consists of ⅛ pound of No. 39 B & S single silk covered magnet wire. The secondary coil to be connected to the 140-ohm receivers comprises 1/16 pound of No. 34 B & S single silk covered magnet wire.

ALTERNATING CURRENT QUERIES.

(854.) Albert H. Beiler, New York, asks:

Q. 1. Will you please inform me whether a polarity changing current has the same effect as an alternating current? By polarity changing current I mean a current that changes at regular intervals; not gradually increasing or decreasing from positive to negative following a sine curve; but one that would be produced by a pole changer or a reversing switch actuated at regular intervals. Would such a current if reversed rapidly enough, operate a transformer or induction coil, and would it have the same effect on a magnet as a true A. C. which produces a field that repels a copper or aluminum ring? It is this latter point I am particularly interested in.

A. 1. A polarity changed current has not the same effect upon electrical apparatus as that of an alternating current. However, such a current can be employed to operate a transformer but not an induction motor. We doubt very much whether a rapidly reversed current would give the same results with the repulsion of aluminum or copper as those obtained with the use of a true sine wave A. C. There is no doubt however, that some results of a trifling nature can be obtained by a rapidly reversed current.

Q. 2. According to the capacity effect in an alternating current, the capacity reactance is exprest as follows: $X = \frac{1}{2 \pi f c}$; X therefore varies as $\frac{1}{c}$. Now since the capacity effect tends to throw the voltage out of phase, it may be likened to resistance, in that the greater the capacity, the less the effective voltage.

That means the more capacity in a line the greater the resistance, yet how does this reconcile itself with the above formula where R varies as $\frac{1}{c}$? Again, if my reasoning has been wrong and the above formula correct, why the objection to a great capacity, since it would lessen the resistance in the conductor.

A. 2. The capacity reactance varies inversely as the capacity and frequency of the circuit; thus by increasing the capacity the value of the fraction becomes smaller, thus the capacity reactance is decreased which means that the resistance in the circuit is decreased when the capacity is increased, and this is actually true. Since increasing the capacity means an increase in the storage of electricity, then a greater quantity of electricity will be discharged per given time with an increase of capacity. The current leads in phase when there is capacity reactance as you mention in your question and which is true.

Q. 3. When an inductance is connected to an A. C. Circuit, a C.E.M.F. is generated which is out of phase with the charging current. Why is it said to be ahead of the current by 90°, since the current has to flow thru the inductance *first* before producing the C.E.M.F. in which case the *current* is ahead? Why does the inductance throw the *line* voltage out of phase with the *line* current? It seems that the *C.E.M.F.* only is out of phase with it, so how does it affect the line E.M.F. This same question by the way may be put as regards capacity where the *C.E.M.F.* charge is out of phase with the charging current, but throws the current out of phase with the line voltage.

A. 3. You are well aware of the fact that whenever an inductance is placed in an A. C. circuit that the current will lag in phase, but not 90 degrees, providing that there is sufficient inductance to produce this effect. It should further be borne in mind that every centimeter of line conductor over which the current travels in the conductor generates a counter-electromotive-force which is directly in opposite phase with that of the imprest E. M. F. The relation which exists between capacity and inductive reactance being that the latter is directly proportional to the inductance, while the capacity reactance is inversely proportional to the capacity. Thus an increase in inductance is a decrease in current, while it is vice versa with capacity reactance.

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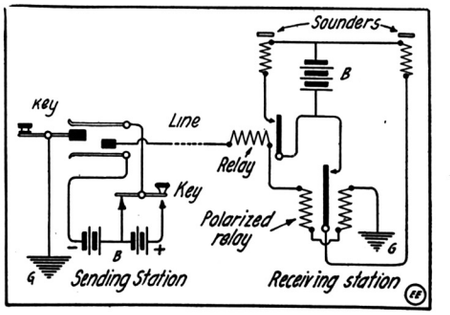
Address photos to—Editor "Odd Photos," ELECTRICAL EXPERIMENTER, 233 Fulton Street, New York City.

QUADRUPLEX TELEGRAPHY.

(855.) Peter Jolsen, Wilmington, N. C., inquires for:



Connections for Original Edison "Quadruplex" Telegraph System.

Q. 1. A wiring diagram of the original Edison quadruplex telegraph?

A. 1. The diagram below gives the connections.

Q. 2. In operating a simplex telegraph and if it is desired to know what distance can be covered with a given equipment what usual procedure should I follow in regards to formulas, etc.?

A. 2. There is a general formula which will give the maximum operating distance with a given equipment; this formula is as follows:

$$l = \frac{NR_r}{2R} + \sqrt{\left(\frac{NR_r}{2R}\right)^2 + \frac{2I_2R_1}{R(I_1-I_2)}}$$

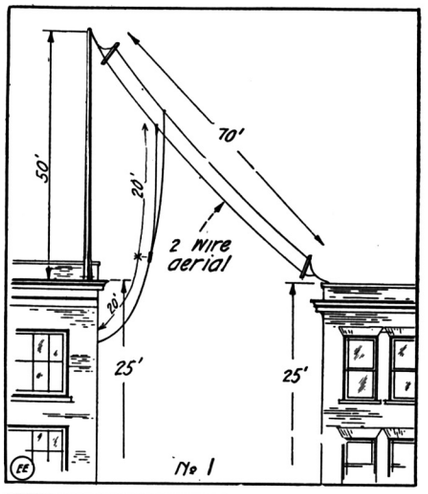
Where:

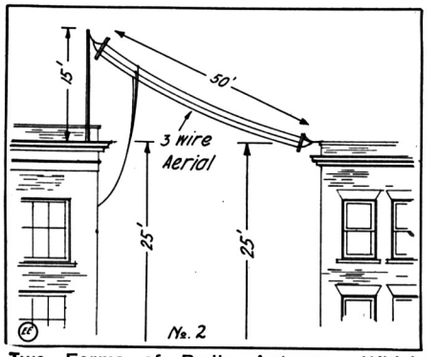
l = Maximum transmission distance in miles.
N = Number of relays in circuit.
R_r = Resistance of each relay in ohms.
R = Resistance of line per mile.
I_2 = Current in amperes which will just cause trip of relay armature.
R_1 = Insulation resistance per mile in ohms.
I_1 = Current in amperes necessary to actuate relay.

INDUCTANCE CALCULATION.

(856.) T. Cass, Toronto, Ont., writes:

Q. 1. Please note these drawings of two different aerials. Could you find space in





Two Forms of Radio Antennae Which Querist Shows. He Wishes to Know Which is the Best of the Two.

vour next publication of the "E. E." to inform me which will give the best results in Wireless Telegraphy? Each aerial contains two hundred feet of copper wire, as you will see by the measurements.

A. 1. Both types of aerial which you submit are satisfactory. However, the first aerial, No. 1, will be more suitable for receiving purposes, while the second one, No. 2, is more efficient for transmitting.

Q. 2. How do you calculate the inductance of a coil in centimeters?

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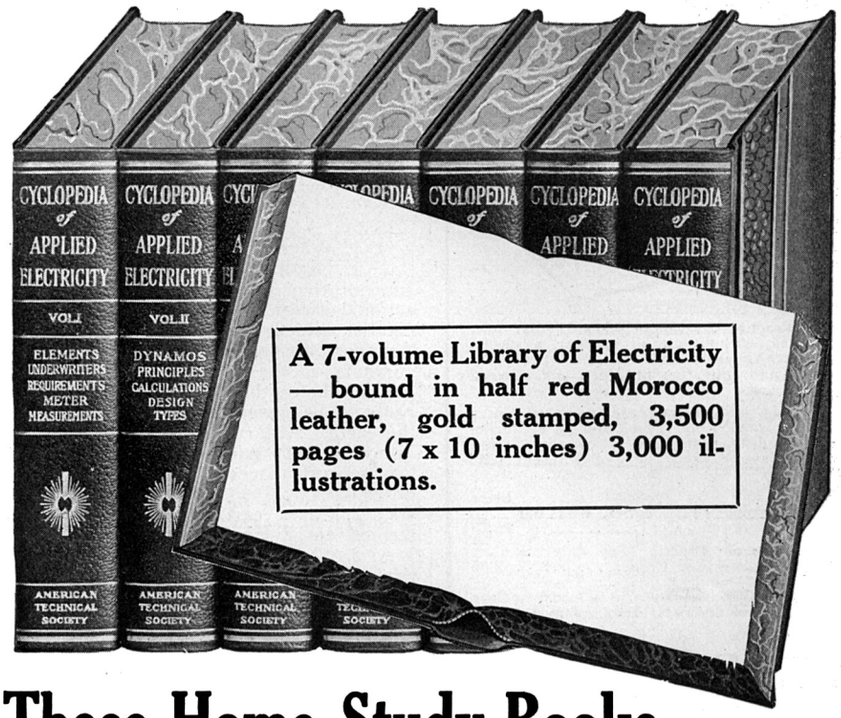
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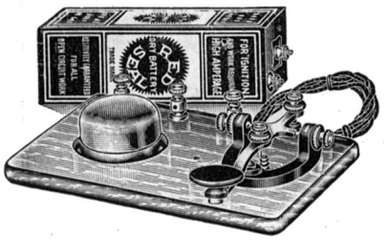
For Learning Telegraph Codes



The Practice Set comprises a regular telegraph key, without circuit breaker, a special high pitch buzzer, one cell Red Seal Dry Battery, and four feet of green silk covered flexible cord.

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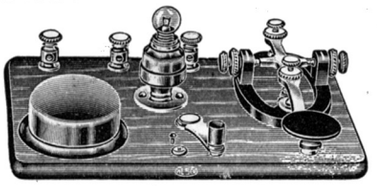

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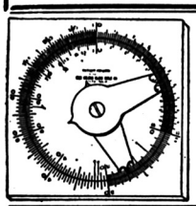

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A. 2. We should refer you to a series of articles published in the March, April and September 1917 issues of this journal which cover the subject of the calculation and measurement of inductance very completely. These copies can be obtained at 15 cents per copy from our "Circulation Department."

EARTH VERSUS AERIAL CURRENTS.

(857.) A. Kramer, Philadelphia, Pa., asks:

Q. 1. Where do *earth currents* originate?

A. 1. Earth currents originate from many sources, two of which are the chemical reaction between certain metals and acids or alkalies which are present in the ground. Another phenomenon which results in earth currents, is the variation of the magnetic field of the earth, which causes electric currents to be generated in metals present in the earth. Altho this phenomenon does not occur in every part of the earth, yet there are several places where this action was noted.

Q. 2. Could earth currents be properly termed aerial currents?

A. 2. No. Both of these currents are entirely different from each other. The latter type of current is generated by the action of water and dust particles floating in the upper air strata.

COMPOSITION FORMULA.

(858.) Joaquin Agusty, San Juan, Porto Rico, wants to know:

Q. 1. I have a stove made of the common coil resistances, built by The National Electric Co., of Chicago, and the base is made of a composition or paste, very hard, which never broke with the hottest tests and is a very good insulator. It has a reddish brown color and looks as if made of asbestos and cement. It appears as if it had been melted in a mould before dry to make it any form desired. I want to know the composition of such paste.

A. 1. We are unable to give you the exact composition of the substance in question. However, several of these materials have been made with a porcelain compound intermixed with another material which withstands sufficient heat.

Q. 2. What is the composition for the making of phonograph records, such as the Edison type. Could the Edison cylindrical records be employed as tubes for spark coils, and flat disc type record as bases for electrical apparatus?

A. 2. Phonograph records are made from a composition of wax, tar and a rubber compound. The exact percentage of these ingredients is kept secret. Another secret compound is composed of shellac and finely powdered mica, compressed hydraulically into the desired form, heat being applied during the compression process. Phonograph discs are unsuitable for building electrical apparatus as they are very brittle and are poor electrical insulators.

Q. 3. How many pounds of No. 24 D.S.C. magnet wire will be necessary for the primary of a loose coupler of 10,000 meters wave length? How many pounds of No. 32 D.S.C. magnet wire will be necessary for the secondary?

A. 3. Two and a half pounds of No. 24 D.S.C. wire will be required for the primary and 1½ lbs. of No. 32 for the secondary.

POWER PLANT QUERY.

(859.) Allen W. Strete, Ohio, writes:

Q. 1. Am unfortunate enough to be without commercial current as I live in the country. Advise me as to what would be the cheapest form of current to use for experimental purposes, batteries or a small engine and a dynamo?

A. 1. We would advise you to employ a small gasoline engine to drive a direct current dynamo, so as to charge a storage battery from which you can derive the proper electrical energy for experimental work. The dynamo should be wound to have a potential of 10 volts and 20 amperes.

Q. 2. What kind of batteries are the cheapest in the long run, dry cells, gravity or storage?

A. 2. Storage batteries are most serviceable, all things considered.

TWO INCH SPARK COIL FOR RESONATOR.

(860.) R. O. Sutherland, South Bend, Ind., asks:

Q. 1. Will a good 2 inch wireless coil with mechanical interrupter operate the small Resonator shown in Fig. 1 of Dr. Strong's last article "Electricity and Life"?

A. 1. It will operate the resonator, but not at its full strength.

Q. 2. If not, will it operate the small Tesla coil shown in his previous article in the May issue?

A. 2. Yes, it will easily operate the small Tesla coil to its full strength.

Q. 3. Is a rotary spark gap necessary to produce best results when a high speed vibrator interrupter is used?

A. 3. It is not exactly necessary but far better results will be obtained by its use, as the oscillatory circuit of the condenser and primary of the resonator is made to oscillate at a greater period, which increases the oscillatory value in the secondary of the resonator.

THE EMISSION OF ELECTRICITY FROM HOT BODIES. By Prof. O. W. Richardson, F.R.S. Cloth bound; 6 by 9 inches; 304 pages, 35 illustrations. Price, $2.75. Published by Longmans, Green & Co., New York City, N. Y.

The student of electro-physics who desires to learn all about the basic how and why of the emission of electricity from the hot bodies will do well indeed to study this authoritative work by Prof. Richardson, who has done considerable work in this field. The opening chapters treat on the theory of ions, the specific charge of the ions, apparatus used in experimental determinations of the charge, the electron theory, the kinetic theory, the quantum theory, the contact difference of potential, etc., etc.

The author then proceeds to discuss the temperature variation of electronic emission, the effect of gases on the emission of electrons, the kinetic energy of the emitted electrons (with various graphs, formulae and tables), the emission of positive ions by hot metals, the specific charge and electric atomic weight of the ions, the effect of gases on positive ions, the emission of ions by heated salts, ionization and chemical action, et cetera. It is a masterly and thoro treatment of the subject.

CHEMISTRY IN THE SERVICE OF MAN. By Dr. Alexander Findlay. Cloth covers; size 5¾x8¾ inches; 255 pages; illustrated. Price, $1.60 net. Publisht by Longmans, Green & Company, London and New York.

Not since the late Robert Kennedy Duncan's book on "The New Knowledge" and "Modern Chemistry" has anything appeared in this same vein covering the advances and present status of Chemistry until the interesting volume by Dr. Findlay, compiled from his lectures for the United Free Church College and given us in this book. It will be of particular interest to readers who make no particular claim to chemical knowledge.

Written from a British viewpoint, it gives us a mental yard stick by which we can gage the great progress that both English and American chemists have made, particularly in the last few years.

Special attention is called to the chapter on Velocity of Reactions and Catalysis as having two viewpoints for consideration which will surely govern future chemistry on the comparison that man in his laboratory resorts to high temperatures, powerful and corrosive reagents, crude, cumbersome and noisy apparatus, while nature building the most complex compounds makes them noiselessly, smoothly, and usually at the ordinary temperatures.

On the importance of the "Infinitesimal to the Finite," Dr. Findlay states in this relation that in Astronomy one deals with magnitudes so vast as to be beyond the grasp of our minds; in the domain of catalysis the magnitudes in some cases are so small that it becomes equally impossible to form a true conception of them.

A subject of particular interest will be found under the heading of "Cellulose and Cellulose Products."

There are interesting chapters covering the electro-chemic products, such as the manufacture of chlorin, caustic soda, aluminium, grafite, etc., as also chapters on Colloids and Synthetic Chemistry.

LABORATORY MANUAL OF INORGANIC CHEMISTRY FOR COLLEGES. By Dr. Lyman C. Newell of Johns Hopkins. Cloth covers; size 5x7½ inches; 240 pages; illustrated. Price, $0.64 net. Publisht by D. C. Heath & Company, New York.

This manual is to be used to accompany any standard text-book in Chemistry and particularly the author's work entitled "A Course in Inorganic Chemistry for Colleges." It can be commended as being well edited, and the illustrations of apparatus, etc., have been carefully considered.

The subject matters themselves are quite complete, but the attitude of the author, taken particularly in the questions asked, are not conducive to the best kind of thinking.

However, this appears to be a very valuable little text-book for the laboratory, as its form is such that it is unnecessary for the student to do any re-reading, while it is sufficiently full to cover all preliminary work necessary. The field that it covers is quite large, but not so great as to make it appear a brief of larger treatises of the same type.

THE NATURE OF MATTER AND ELECTRICITY. By Comstock and Troland. Cloth covers; size 5½ x 8 inches; 203 pages, illustrated. Generously supplied with tables and references. Price, $2.00 net. Publisht by D. Van Nostrand Company, New York City. 1917.

This book purposes to be an outline of modern views on the nature of matter and electricity. In reality it is an attempt to popularize these modern ideas, with the usual result that it is neither scientific or popular. It is too bad that a man like Serviss could not be called in to really popularize such important subjects which no doubt are of considerable interest to the scientific laity. Particularly the analogies are not very good, and unless an analogy helps to very clearly illustrate the point, it is very often better to stick to the idea itself.

The book can be recommended for one thing, that the references from which the different chapters have been taken have not been omitted and these would be of considerable help to the student or to the scientist who would want a convenient source of reference on the several subjects touched on in this volume.

X-RAYS. By G. W. C. Kaye, M.A., D.Sc. Cloth covers; size 5½ x 8½ inches; 285 pages, illustrated. Price, $3.00. Publisht by Longmans, Green & Co., of New York and London.

Dr. Kaye's second edition of X-Rays is a book to be commended to any one interested in this absorbing subject. Not alone are the X-Rays treated on, but the book covers the phenomena of a Discharge Tube, Cathode Rays, Positive Rays, and some very complete data on the construction of X-Ray Tubes. It is a pleasure to know that the scholar of J. J. Thompson has remembered his saying that "When measurement commences science begins," and the reader will find that nearly every subject handled by Dr. Kaye carries with it data relative to measurement, making for a very clear understanding, even tho the reader may not be interested from that exact viewpoint.

This book is a good example of the possibilities of interweaving personalities with scientific data, and thruout this volume the personal touch is very evident.

It is a book, not only for the scientist and physicist who is interested in this subject, but also for a great number of professional men who are using or are in direct contact with this field.

The Appendix is well indexed and contains some very valuable tables and data.

It can be well recommended as the best book in the English language on the subject of X-Rays.

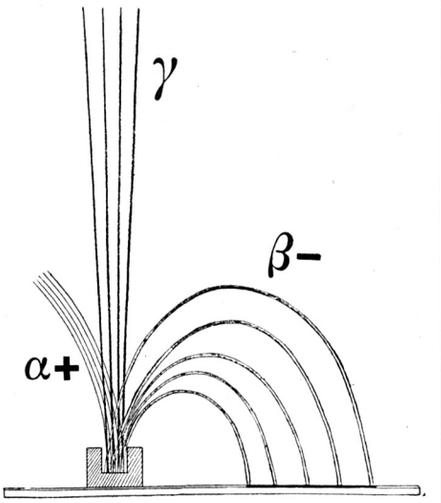
(*Continued from page* 451)

Radium deposit is 26 minutes; for Actinium deposit—34 minutes and for Thorium deposit—10.5 hours.

The active deposits, when heated on a platinum wire or dish, volatilize before white heat and are redeposited on the cooler bodies in the neighborhood. Rutherford also demonstrated that induced activity could be concentrated on the negative electrode in a strong electric field, indicating that the radioactive carriers have a positive charge. The distribution of the active deposit in a gas at low pressures has been investigated by Makower and Russ.

—Photos courtesy of "Radium L't'd."

(To be concluded)



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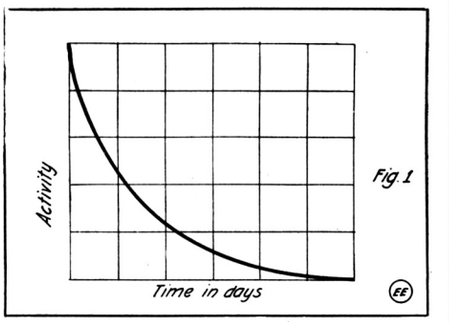
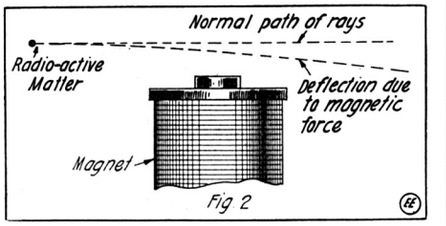
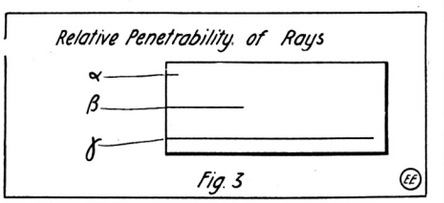


Decay Curve for Radium Emanation.



Magnetic Deflection of Rays.



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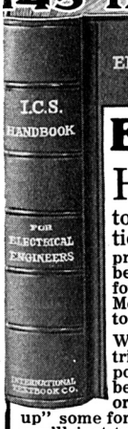

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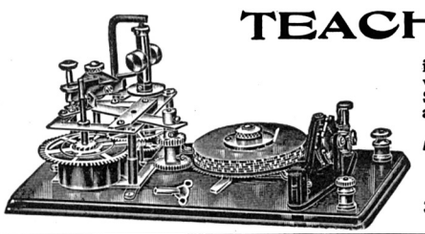

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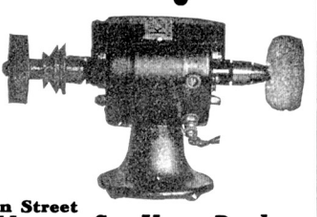

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THE CAUSE AND NATURE OF MAGNETIC CURRENTS.

(*Continued from page* 455)

be moving in the same direction and will re-enforce each other.*

The formation of an electromagnet is now easily and simply explained. As has been seen, a wire bearing a current draws the surrounding ether towards it from all sides. If the wire is coiled, the ether is drawn toward the wire of the coil from both inside and outside. The supply of ether outside the coil is practically unlimited, but within the coil the supply is limited. Part of this ether, as seen in the experiment with a wire bearing a current, is repelled from the wire and part is drawn along with the current in the wire and is carried outside. The result is the formation within the coil of a more or less complete ether-vacuum within the coil. Into this ether-vacuum the surrounding ether rushes just as air rushes into an air vacuum. If the currents rushing into the ether-vacuum were not moving from both directions the point of greatest vacuum would naturally be at the center of the inside of the coil; but as these currents are coming from both directions the result is a partial compression, or, more properly less of an ether-vacuum, at the center than at points midway between the poles and the center. Hence the greatest lateral "attraction" or pressure is a point between the center of the coil and the poles. This has been shown by preceding experiments to be exactly the condition existing in a magnet. Currents from the inside of the coil at the central point, on account of a partial excess of ether at this point, passing thru the wire join currents from the outside meeting at the external center of the coil form a neutral or repulsive point which has already been noted in the magnet and proven to exist by the field of iron filings and the photographic plate.

Attraction and repulsion hardly need explaining. If two magnets or coils are placed so that the north pole of one is over the south pole of the other, the currents surrounding each will be moving in the same direction and will be in effect one continuous current. This will produce an ether-vacuum between the two, for both currents are moving toward the poles of their respective magnets tho in the same spiral direction, a continuous spiral, and an ether-vacuum is formed between them, just as an ether-vacuum is formed in the coil, and the two magnets or coils will be drawn together, or rather forced together by the ether rushing towards them from the opposite poles. If one coil is now reversed and the like poles of the magnets are brought together the currents surrounding will be moving spirally in opposite directions, the particles of ether drawn in from the sur-

** Note. The difference between the upper and the lower side of the needle is slight but even this is sufficient to give a preponderance of force on the lower side of the needle. In addition to this it must be borne in mind that the currents surrounding the needle extend to a considerable distance from its surface and thus give a considerably greater preponderance to the forces on the under side. This preponderance of force on the under side of the needle increases the tendency of the currents on the under side of the needle to re-enforce each other and move in the same direction and this is sufficient to produce the result.*

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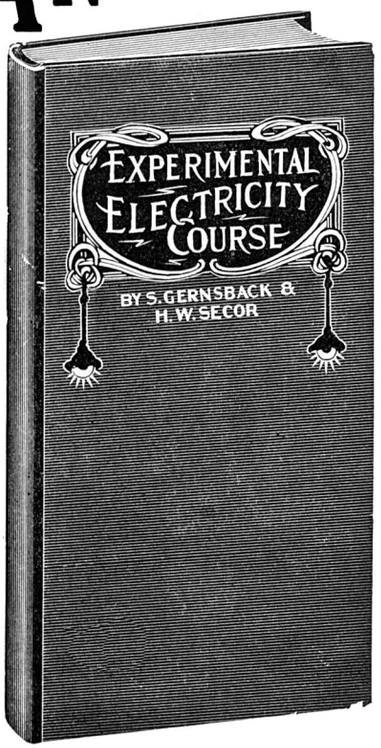

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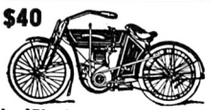
$40 

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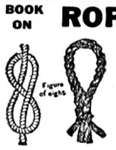

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rounding ether will accumulate and the excess of ether, in rapid motion in opposite directions, seeking to escape and opposing each other by their motion, will drive the magnets apart. If two-magnets are placed side by side with opposite poles together, the currents between them will be moving in the same direction, producing a vacuum and the two will be drawn together. If like poles are placed side by side the currents will be moving in opposite directions, a condensation will be formed, and the magnets will b repelled.

Here two experiments heretofore made by others may be explained. These experiments re-enforce what has already been set out. Indeed, these experiments rightly understood are alone sufficient to prove part of that which has been advanced; but they have never been understood and have never been so used.

A flexible, free wire bearing a current coils itself about a straight bar magnet, coiling and uncoiling and recoiling as the current is reversed. Here the currents of ether drawn to the conductor simply force the conductor to coil, uncoil, and recoil in such a manner that the currents moving toward the conductor are moving as nearly as possible in the same direction as the currents moving spirally about the magnet.

If a wire with its lower free and plunged in mercury be suspended over the north pole of a bar magnet and a current of electricity be past downward the wire will revolve clock-wise about the magnet. This is not a contradiction but an additional proof. As seen in Figure 10, the ether currents moving toward and along the wire will be drawn inward by the currents rotating about the poles of the magnet. This will aid in producing a greater ether pressure inside the circle described by the end of the wire, and the wire will be forced outward. Moreover, the currents on the side of the wire on which the spirals are approaching will not reach the wire but a partial ether-vacuum will be formed in advance of the wire while the currents drawn in on the other side of the wire will form a condensation. Thus the wire will move away from the condensation and toward the partial vacuum and the wire will rotate clock-wise—contrary to the motion of the currents about the pole of the magnet and contrary to the motion of the several iron articles shown in the previous experiment.

Having proven the old theories of magnetism to be absolutely false, there is no reason why we should not point out their absurdities. It is desired especially to call attention to and emphasize these absurdities, because the fact that these absurdities were recognized by even the immature students of physics, started this investigation in the first place, and because there are other absurdities which we shall meet later; and if philosophy has promulgated and upheld absurdities in one case, it may well have done so in other instances. It will be well to remember this fact.

As to these absurdities. In the very nature of matter, molecules are spherical. (A little thought along the lines of well known laws of matter will show this. I do not care to take it up here, but I will discuss it with anyone who desires to do so.) Spheres are the most difficult of all shapes to permanently magnetize. It is almost impossible to secure definite and permanent poles in a perfect sphere. Hence, it would be difficult to conceive of molecules as magnetized sufficiently so that they could be arranged pole to pole, as the old theories supposed to be done in producing magnets, and equally difficult to so arrange them as to produce an appreciable attraction.

According to the molecular theory, every molecule is in rapid motion and this motion is increased by raising the temperature. To

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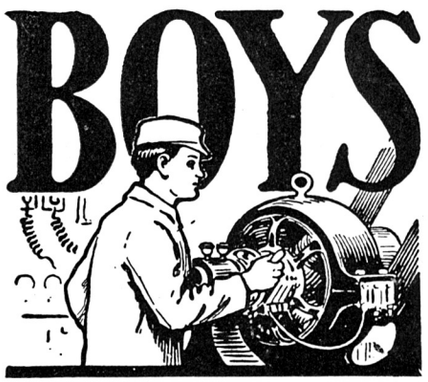

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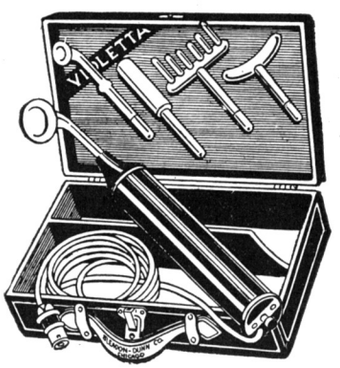

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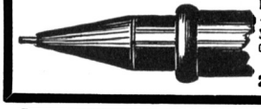

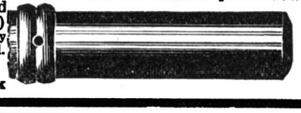

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magnetize iron, therefore, would be to lower its temperature by checking the vibrations of the molecules, while in reality the temperature is raised during the process of producing an electromagnet. If the molecular theory is true, to so change and check the molecules, conceiving it to be possible, would be to disintegrate the substance.

In the theory of the molecular arrangement of magnets it is asserted that magnets are surrounded by "lines of force," "line of tension," "mere lines of direction," "imaginary lines, like lines of latitude and longitude," not themselves in motion but capable of producing motion. This is contrary to the laws of work and the laws of conservation of energy. Motion and work can only be produced by motion. Potential energy must be changed to kinetic energy before motion can be produced or work done.

In all theories on magnetism it is assumed that there are lines of force that move without motion—or is it "emerge" without motion—from the north pole and "pass to" the south pole—and yet without motion—moving from the north to the south pole, yet without motion, being only "lines of tension or direction." Here, too, we have lines of force moving or passing, and yet not moving, in only one direction but exerting equal force in both directions and doing equal work in both directions, for both poles "attract" equally. Was a more confusing and illogical conglomeration ever put out in the name of science? This is contrary to all laws of force. It is worse than the wheels within wheels and cycles within cycles of the old astronomical theories.

In the theories of magnetic induction it is assumed that the induced current is produced by cutting lines of force passing, or existing, between the north pole and the south pole as between the poles of a "U"-magnet, the lines always passing or "existing," from the north pole to the south pole. As a fact, the result is produced by thrusting either pole of a straight magnet into a coil or withdrawing it therefrom. Therefore, if the lines pass, or exist, from the north pole, when the coil is thrust down upon this pole it is moving in the same direction as the lines, when it is withdrawn it is moving against them. Similarly, when the coil is thrust over the south pole it is moving against the lines and when it is withdrawn it is moving with them. That currents are produced in both of these cases is self-contradictory, for in two cases the coil is working against the lines and in two cases with the supposed lines. Therefore, opposite causes are producing the same result. It is not a sufficient answer to say that the direction of the current is changed, for the reason that for half of the time the coil is moving with the supposed lines and half of the time against them, and in all cases work must be done against force to produce a reaction.

In the theory of magnetism, when the molecules are so arranged as to produce a magnet, the north poles of all molecules are in one direction and all south poles of molecules are pointing in the opposite direction.

Each molecule is then exerting force in the same direction, *i. e.*, a molecule at the north pole of the magnet exerts force upon the one next to it in the direction of the south pole of the magnet, and so on to the final molecule at the south pole; and the molecule at the south pole of the magnet in the same line is exerting force on a molecule next to it in the direction of the north pole, and so on to the original molecule at the north pole of the magnet. Meanwhile, the molecule at the north pole is attracting iron and the molecule at the south pole is attracting iron. To a certain

extent, at least, this is the thought, as of old, of a man pulling himself over a wall by his boot straps. It sets at naught the laws of action and reaction. According to this, too, the ideal magnet would be a disk the thickness of two molecules, for here there would be no waste energy. The intermediate molecules are, in the theoretical magnet, merely holding together, or rightly aligned, the molecules at the poles. This is contrary to known facts. Besides, the thin disk composed of two layers of molecules, if such a thing were possible, is the most difficult of all forms to magnetize. Moreover, a chain is no stronger than its separate links. The whole strength of the theoretical magnet, then, is represented by the strength of the molecules on the face of the cross-section of its poles. That is, a thin layer of tiny molecules, so small as to be invisible under the most powerful microscope, are capable by some *mystic* power within themselves, of lifting pounds and tons of weight. This is an explanation that does not in any sense explain.

A solenoid is a magnet. Place an iron core within it and it becomes a stronger electromagnet. According to the molecular arrangement theory, billions of molecules must be changed from their normal position, and the action must be upon billions more molecules than there are in the effective molecules at the poles of the magnet. All of this is waste energy. Yet this enormous waste of energy makes the magnet stronger. This is contrary to the laws of energy.

As stated above, a great amount of energy is exerted in arranging the molecules of an electromagnet. When these molecules are thus arranged they are placed opposite poles together and as they mutually attract each other they will cling together. Yet if the core is soft iron the moment the current in the coil is broken some mysterious force overcomes the force which arranged them pole to pole and the force of the mutual attraction of these billions of molecules, they rearrange themselves contrary to all laws of magnets and the iron ceases to be a magnet. This is the height of absurdity.

Finally, an electromagnet is produced by the passage of an electric current thru a solenoid containing an iron core. Remove this iron core and the solenoid is still a magnet. But here there are no molecules to be arranged pole to pole, for there are no molecules present, and the whole theory of the molecular arrangement of magnets falls to the ground.

FINIS.

ACTION AT A DISTANCE AS EXHIBITED IN SELENIUM CRYSTALS.

(*Continued from page* 459)

transmitted much in the same way that a sound wave is transmitted along a steel rail.

However we do not know that the light can produce a vibration of the molecules. Each molecule of selenium has at least one electron loosely attached to it. This electron probably has a definite location with regard to the center of the molecule, when it is not disturbed. If so there must be a space lattice of electrons in the selenium crystal exactly corresponding to the space lattice of the molecules shown in Fig. 4. Since light is an electromagnetic phenomenon we can well understand how the electrons in the space lattice could be set in vibration and further how these electrons by electrostatic repulsion would set neighboring planes of electrons in vibration. When the electrons are in vibration they are more easily removed from their equilibrium positions in the molecules by a voltage across

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100,000 MORE FOR SIGNAL CORPS.

To fill the Army Signal Corps, the War Department may decide to draft an additional 100,000 men. The signal service has asked for a decision on the method to pursue in filling up gaps, existing in the aviation and telegraph branches, and the general staff is expected to answer in a few days.

The Draft Law permits the filling of units which are now below strength, but it is held that an added 100,000 instead of any of the 687,000 of the original draft would be necessary for the Signal Corps.

Men who join the aviation section will have a chance to train either in American schools or in England, France or Italy.

England, it is learned, has establisht a flying school in Egypt, which is used chiefly by the Canadian corps.

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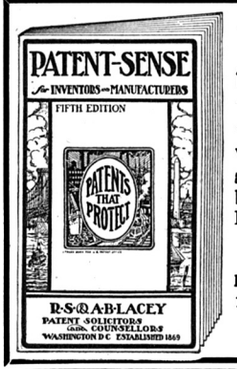

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the crystal. Thus light increases the conductivity of selenium by lowering the stability of the electrons in the crystal structure and these electrons may communicate their state of unrest to neighboring electrons in an almost human fashion. But if this be the explanation, this new property of matter continues to be about as much of a mystery as any other action at a distance.

EXPERIMENTAL PHYSICS.

(*Continued from page* 460)

passes outside of cardboard BC. Seeing the bull's-eye X with one eye and the sight with the other eye, *i. e.,* seeing both the bull's-eye and the sight, he has only to line up his sight to the bull's-eye, pull the trigger, without flinching, and the bull's-eye is hit right in the middle, thus performing the impossible (?). Measuring the angle EX-"e" one can readily determine just how small BC must be, and for those unfamiliar with geometry, the correct size may be found by trial, beginning with a small piece and gradually increasing the size of the cardboard until the largest is found (the larger the cardboard the more marvelous appears the feat). Everyone owning an air rifle, Boy Scout rifle or other fire-arm should perform this trick and learn to mystify his friends by his marvelous skill??!

Cut a small piece of clear glass (preferably plate glass) so that two of its sides are parallel (MN and OP in Figure 44). Place the glass on paper and draw line AB up to the side OP not meeting perpendicular. With eye close to the table look across MN until the eye is in line with AB. Draw the line from the eye to MN which appears to coincide with AB if produced. Call it CD. On looking up you will be surprised to find that instead of being in line AB, *i, e.,* EF, it will be some distance away from EF and hence not in the prolongation of AB at all. Remove the glass and draw CB. Our line ABCD, represents the path over which the light in the direction of AB traveled. We notice, therefore, that when the ray of light reached the glass at side OP it bent (was refracted; see Lesson 8) toward the perpendicular XY, while on passing out from the glass at MN it bent away from the perpendicular WZ. The law is stated—*"Light passing from a lighter to a denser medium is retarded in speed and bends toward the perpendicular; light passing from a denser to a lighter medium increases in speed and bends away from the perpendicular."* It is upon this law that the use of all lenses and optical instruments employing lenses depends; hence its importance cannot be overemphasized.

There are two kinds of lenses, *convex* and *concave.* In Fig. 45, lenses number 1, 2, and 3 are convex; 4, 5, and 6 are concave. Convex lenses curve outward, whereas concave lenses curve inward. There are three types of convex (1) double, (2) plano, (3) concavo and three types of concave lenses (4) plano, (5) double, (6) convexo. The action of the double convex and double concave lenses is typical of their respective types and only those two will be considered in what follows. It should be noticed that *all convex lenses are thicker at the middle than any other place, while all concave lenses are thicker at the ends.* Also because of the above stated law of refraction, light bends around the thicker part of the lens. The sun's rays and other rays coming from a great distance are considered to be parallel. In Fig. 46 we see that when parallel light passes thru a convex lens (A) the rays bend toward each other (converge) and meet at a point F. This point is called the *focus* of the lens, and the distance of this point from the center of the lens is called the *focal length.* In the case of the concave lens, Fig. 46 (B), we see that the rays bend away from each other (diverge) and hence appear to come from the point F, on the same side of the lens as the parallel light. This point is also called the *focus* and its distance from the center is called the *focal length.*

EXPERIMENT 54—.

Altho the focal length of a lens is one of its most important properties, it is the easiest to determine experimentally. The best method of finding the focal length of a convex lens is to place a sheet of paper on the ground and holding the lens in the hand move the hand slowly up and down until the image of the Sun is sharply seen on the paper. Measure the distance from the lens to the spot (Sun's image) and add to it *half the thickness of the lens.* In the case of a concave lens the procedure is slightly different. The image of the Sun being on the same side as the Sun cannot be caught on a screen, since the screen would not permit the rays to pass thru. (Also the image is not a real one, since the rays do not actually come from F in Fig. 46-B, but only *appear* to come from there). However, holding the lens in front of the right eye a small image of the Sun will be seen thru the lens at the point F, (Fig. 47). Looking at the tip of a pencil held in the left hand, move the hand until with the left eye the pencil tip is seen to be out from the lens the same distance as the image of the Sun is seen to be with the right eye. Have your partner measure the distance from the lens to the pencil tip and add *half of the thickness of the lens* and you have the focal length.

In the case of a camera we have simply to point it at the Sun, get a clear image on the ground glass and measure the distance. When two or more lenses are used in combination, the procedure is the same as for a single lens. In all these experiments a distant tree or window or chimney, or other object may be used instead of the Sun, but the writer prefers to use the Sun since it brings back the days when the focal length was found by him in school using the neck of the boy seated in front of him as the screen. When the boy began to fidget and scratch his neck, the writer knew that the lens was a focal distance away from the neck, but then his interest stopt when the neck began to burn. Now we are interested in actually measuring the focal length. The question arises, "why measure the focal length, what good is it when you have it?" Just this:—*The magnifying power of a lens is equal to* 10 *divided by the focal length.* (Measured in inches.) *The magnifying power of a telescope is equal to the focal length of the objective lens divided by the eyepiece lens.* The magnifying power of the opera or field glass is also the focal length of the objective divided by the focal length of the eyepiece. *The magnifying power of a compound microscope is equal to ten times the length of the tube divided by the product of the focal lengths of the objective and eyepiece.* From these and many other considerations the importance of knowing the focal length of a lens is apparent.

The readers should as exercises measure the focal lengths of lens available and compute the various magnifying powers according to the laws just stated. This subject of light is very fascinating and will be continued in the next lesson which will treat of "Photography." The writer sincerely trusts that interest is aroused in the reader and that the reader will consult the standard text-books for further information on the subject.

(*To be continued*)

PATENT ADVICE

Edited by H. GERNSBACK

In this Department we publish such matter as is of interest to inventors and particularly to those who are in doubt as to certain Patent Phases. Regular inquiries addrest to "Patent Advice" cannot be answered by mail free of charge. Such inquiries are publisht here for the benefit of all readers. If the idea is thought to be of importance, we make it a rule not to divulge details, in order to protect the inventor as far as it is possible to do so.

Should advice be desired by mail a nominal charge of $1.00 is made for each question. Sketches and descriptions must be clear and explicit. Only one side of sheet should be written on.

ELECTRIC BULB.

(176.) Thomas Sheehan of Duluth, Minn., has invented a novel electric bulb; the principle idea being to do away with the glass tip in a certain manner, so that it cannot be broken off easily. In other words it will not project as in the present style lamps. He wishes to know if this idea is patentable.

A. This is indeed a very good idea—as simple as it is good. We do not see any reason, technically speaking, why the bulb could not be made in the manner described by our correspondent, but as a precautionary measure, we would advise our correspondent to get in touch with a patent attorney to make search in the patent office at once.

MUFFLED BELL.

(177.) Paul B. Eaton of Baltimore, Md., has been reading about the *bell softener* which has been discust quite a number of times in these columns, his idea being to use an ordinary clock-maker's cathedral gong: *i.e.*, a wire gong. This is usually made of one piece of spiral steel, and the sound given off by this gong is quite pleasing. He wishes to know if a patent can be obtained on this device.

A. The editor of these columns has been using a device of this kind for some ten years, and there is one in our office which has been there for quite a while. There is nothing new contained in the application of a bell clapper striking the cathedral gong. No patent could be obtained on this.

TELL-TALE WATER GAGE.

(178.) Mr. John Murphy of Halifax, N. S., submits to us information about water gage or tell-tale. The idea being to treat the water gage in such a manner that when the water in the boiler is too low or too high instead of using it or inspecting it, an alarm bell will ring and will continue to ring until the condition is remedied.

Our correspondent wants to know if such a thing is practical and if it can be patented. Also if there exists a demand for this device.

A. While there are several devices of this kind on the market, without knowing what the idea consists of it is quite impossible to tell whether it is patentable or not. Our advice is to get in touch with a patent attorney.

SELENIUM CELL DEVICE.

(179.) Robert Knowles of Toronto, Can., has submitted a rather complicated device whereby a gas jet cannot be lit without introducing a lighted match thru a certain opening, which in turn causes selenium to act on a relay, the latter opening the gas flow.

A. While this idea is very ingenuous, and while we have no doubt that a patent can be obtained upon the device, we do not think the idea is very practical; at best there would be only a very limited market for the device.

AMPLIFIER.

(180.) Clyde Fitch, Pittsfield, Mass., has invented an amplifier which is supposed to work by exciting the field of a small alternator. Several other points of information are given as to how this amplifier could be made to work.

A. It is impossible to state whether a device of this kind will work without trying it out. If our correspondent has faith enough in the idea, we advise having a model built for testing purposes.

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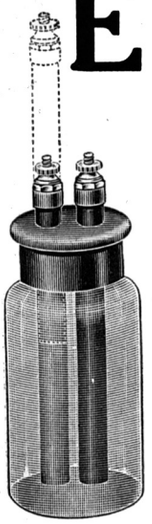

HERE is a little battery that will be highly welcomed by every experimenter all over the country. It is the first low priced, as well as fool-proof chromic acid battery on the market. It is a little wonder, and for the small price we ask for it, it stands unmatched.

Now, we do not wish to mislead you, so we'll tell you at the start what this battery WILL NOT do. It will NOT charge storage cells, it will NOT run a large motor for hours, it will NOT run a big spark coil. It is NOT a very big battery.

BUT it is an ideal battery for electrical experimental work where a very powerful current is not required. This battery will light a 2 volt lamp for several hours on one charge; it will run a small toy motor surprisingly well; it will do small electroplating work; it is ideal for testing work; it gives a fairly steady current, **and as the zinc electrode can be pulled clear of the electrolyte, no materials are used when battery stands idle.**

Only best materials go into the making of this battery. Best Amalgam Zinc only is used, as well as a highly porous carbon to ensure a steadier current. Handy binding posts are used. We furnish enough chromic salts for 4 charges. Full direction for operation and care of battery are included. Each battery tests 2 volts and 10 amperes when set up fresh. Not over 2 amperes should be drawn from battery continuously. By using six or eight of these batteries, a great many experiments can be performed. No solution can run out of this battery if upset by accident. This makes it an **ideal portable battery,** such as for operating a bicycle lamp, or as other portable lamp, where a powerful light is not required, for boy scouts' field telegraph work, operating telegraph outfits, etc., etc. Size over all is 5"x2". Shipping weight, 1 lb.

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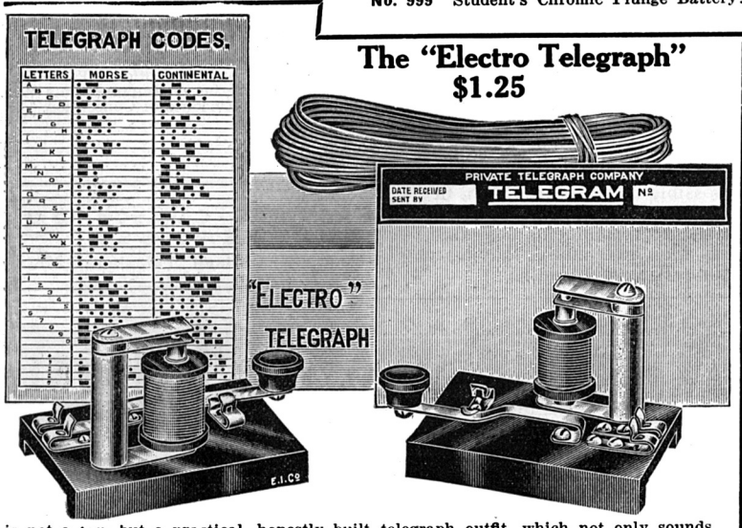

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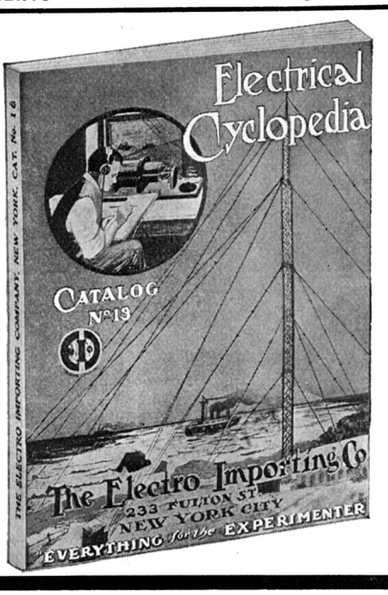

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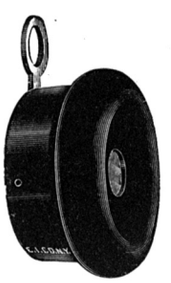

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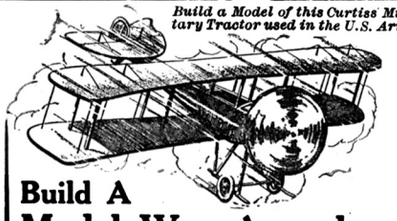

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ELECTRICITY BEING USED TO HASTEN CROPS.

(*Continued on page* 439)

together with the periods of working are important factors in the welfare of the installation. The current expended at Carnarvon is economical in working. The current required at the primary terminals amounts to 450-460 watts per acre per hour (approximately only half a unit); the reason for the discrepancy is entirely atmospheric, the energy required being greater in proportion to the prevailing humidity to make up for the sundry current loss. This occurs on dull heavy days when mist or heavy dew prevails, whereas on prevailing dry periods the efficiency is uniform.

At Carnarvon the apparatus is fixt permanently in a small shed, and is connected to the main cable which supplies electric light for the residence, the outbuildings and farm. The initial voltage is 220 volts continuous current, and passes thru a controlling switchboard to the intensifying apparatus. The chief feature of the overhead wiring is the careful manner observed in insulating the wires, which are suspended over the respective garden plots—a uniform height of 7 feet has been adopted in order to allow freedom for the garden staff to carry on the work of cultivation when the current is not in use.

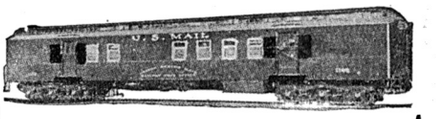
Electroculture has past the back-garden, amateur stage. It is now a serious proposition. But knowledge of its possibilities and limitations is scanty. It falls into place with other possibilities of development in plant industry, which will only reach fruition by the help of well-organized, large-scale research and experiment supported by public funds.

CHEMICAL ACTION OF STORAGE BATTERIES.

(*Continued on page* 473)

If a battery is allowed to stand on open-circuit after charging, the electromotive-force falls in fifteen or twenty minutes to the value corresponding to the density of the acid. This is due to solution around the plates becoming saturated with lead sulfate. On discharge, when the voltage has fallen below the value corresponding to the density of the acid, standing on open circuit brings it back to normal value. In this case the recovery, as it is termed, is due to the diffusion of the sulfuric acid into the pores of the plate where it has become exhausted.

If a charged cell is permitted to stand idle, the density of the acid slowly depreciates, and the quantity of electricity obtainable from it diminishes from day to day. This is known as the *self-discharge* of the battery, and for a cell in good condition amounts to from one to two per cent per day; if impurities are contained in the acid, it sometimes will amount to 50 per



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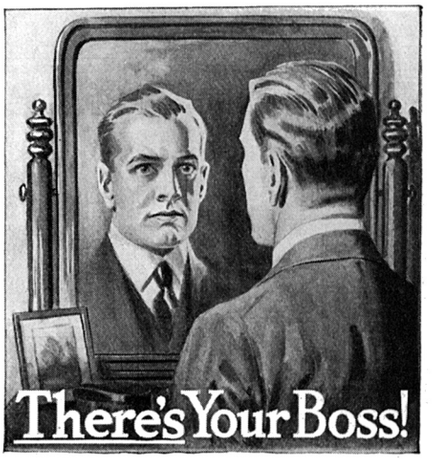

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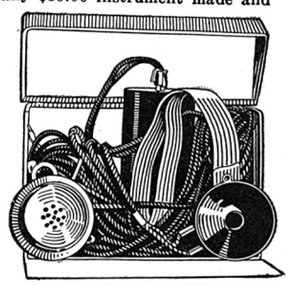

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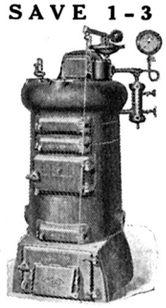

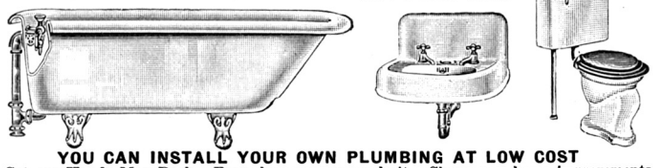

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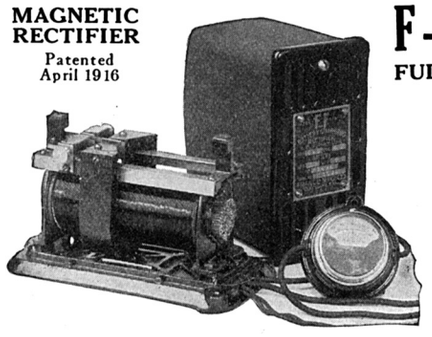

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cent per day. The self-discharge of the lead sponge plate is more liable to occur than that of the peroxid plate, because it is affected by a much larger number of causes. It is fatal for the lead plate if the acid contains any metal which is more electro-negative than lead when in contact with sulfuric acid, for the impurity would become precipitated on the plate and thus produce a short-circuited local element. The lead would thereupon tend to dissolve and deposit hydrogen on the impurity. If the over-voltage of the impurity is not too great, this would in fact take place, and the lead plate would change to sulfate. The potential of the cell: Pb sponge. / Sulfuric acid / Platinized Pt + H_2 is 0.33 volt, hydrogen being the positive pole. A current could be taken from this cell on closing the external circuit; lead sulfate would be formed on the lead pole and hydrogen would be deposited on the positive pole. But if some metal were to be substituted for platinum for which the over-voltage is 0.33 volt or more, evidently hydrogen could not be liberated, and therefore no action would take place. Consequently only the metals standing on the left of the following table would be dangerous for the accumulator; those on the right could exist as impurities in the acid without the least danger, even tho some of these are more electro-negative than lead.

TABLE.

	Over-voltage		Over-voltage
Platinized Platinum	0.005	Palladium	0.46
Gold	0.02	Cadmium	0.48
Iron	0.08	Tin	0.53
Platinum, polished	0.09	Lead	0.64
Silver	0.15	Zinc	0.70
Nickel	0.21	Mercury	0.78
Copper	0.23		

As made apparent from this table, platinum is the *most injurious impurity.* It has been found that one part of platinum in a million of acid will produce a rapid self-discharge of the lead plate. It has been found, however, that metals when present together can produce a rapid self-discharge, *which alone cause scarcely any action.* An explanation of this cannot be given at present.

The self-discharge of the positive plate takes place more slowly than that of the lead sponge plate. Metallic impurities are of no effect on the lead peroxid, for they would not become precipitated upon it. The only kind of spontaneous discharge is due to local action between the peroxid and the lead of the support, which together form a short-circuited element, and this is of importance only for plates with a thin peroxid layer.

Another cause of self-discharge of a battery is the presence of salts of metals that can exist in more than one stage of oxidation. For example, an iron salt would be oxidized to the ferric state on the lead peroxid, and would thereupon diffuse to the lead plate and oxidize it to sulfate, thus gradually discharging both plates.

EXPERIMENTAL CHEMISTRY.

(*Continued from page 477*)

bonat (Na_2CO_3) by the addition of more coal in the black-ash fusion; the reaction being:

$$\begin{matrix} CaCO_3 & + & C & = & CaO & + & 2CO \\ Na_2CO_3 & + & CaO & + & H_2O & = & 2NaOH & + & CaCO_3 \end{matrix}$$

PROPERTIES:—Physical:—1. The physical and chemical properties of Sodium and Potassium are quite similar, therefore the properties of both will be given under one heading.

Both are white solids of acrid and nauseating taste.

2. Both are very caustic, dissolving the flesh.

3. They are very deliquescent and soluble.

4. Sodium hydroxid imparts a flame of yellowish color, while potassium hydroxid imparts a purple color.

Chemical:—1. They neutralize acids and form salts.

2. They are both strongly alkalin.

3. They react on many metals.

4. They absorb carbon dioxid and form carbonats.

5. They react with fats and oils to form soaps.

USES:—Small amounts of these hydroxids are used in chemical laboratories, but the most important use is that of soap-making. Fats and oils are mainly stearin (or glyceryl stearat), $C_3H_5(C_{18}H_{35}O_2)_3$; palmitin (or glyceryl palmitat), $C_3H_5(C_{16}H_{31}O_2)_3$; and olein or glyceryl oleat, $C_3H_5(C_{18}H_{33}O_2)_3$; C_3H_5 being the glyceryl radical. Glycerin or (glycerol) is $C_3H_5(OH)_3$.

In *saponification* the hydroxid of sodium or potassium acts on the stearin, palmitin, or olein, and liberates glycerin, forming sodium stearat, etc.

$$\left\{\begin{matrix}\text{Sodium}\\\text{Hydroxid}\end{matrix}\right\} + \text{glyceryl}\left\{\begin{matrix}\text{Stearat}\\\text{Palmitat}\\\text{Oleat}\end{matrix}\right\}$$

$$= \text{sodium}\left\{\begin{matrix}\text{Stearat}\\\text{Palmitat}\\\text{Oleat}\end{matrix}\right\} + \text{glycerol}$$

The stearat, palmitat, and oleat of sodium or potassium are the chemical names for soaps. They are soluble in water: hence a solution of sodium chlorid, in which they are insoluble, is used to precipitat them.

It may be of interest to the reader to give an explanation of the action of soap. Soap dissolves in pure (or soft) water, and the faintly alkalin solution very readily gives emulsions with the skin or the fatty matters in soiled cloth. Thus the fatty matter is removed, and with it is taken out mechanically any dirt in other forms, such as carbon, etc. If soluble salts of calcium or magnesium are present in the water, an insoluble stearat, etc., of these metals is formed and precipitated as a lime or magnesium soap; hence the soap will not dissolve till these salts are removed. The quantity of soap necessary to make a lather is the basis for estimating the hardness of water. The harder the water the more soap required.

Therefore we may safely conclude that the most important use of sodium and potassium hydroxid is in the manufacture of soap which runs into thousands of tons annually.

They are also used in bleacheries, in paper making, in refining oil, etc.

EXPERIMENT No. 98:

Pour 10 or 15 cc. of water into an 8 ounce wide mouth bottle and have a cardboard or paper to cover it. (Do not use a glass plate as a cover), as a slight explosion may occur upon the disappearance of the metal; (Fig. 89). Take a small piece of metallic sodium with a pair of forceps, about the size of a pea, and drop it into the bottle containing the water, covering the latter immediately with a piece of cardboard or paper. Notice how the metal reacts with the water.

While the action is going on, make the combustion test, by removing the cover and quickly thrusting a lighted splint into the bottle. If there is a flame, note the color.

It may be that the operator failed to notice the phenomena which took place when the first piece of sodium was introduced; in that case, repeat the experiment, using a clean bottle, and water.

$$Na + H_2O = NaOH + H$$

Save the liquid, which is sodium hydroxid and evaporate to dryness, and examine it as to color, causticity and solubility.

EXPERIMENT No. 99:

Examine a piece of freshly cut metallic sodium. (Do not handle the metal with your fingers, but use a pair of forceps). Note its color, lustre, and hardness.

Boil about 10 cc. of water in a test tube, and pour it into a clean bottle, and while still hot drop a piece of sodium (a fresh piece) into it and cover the bottle with a piece of cardboard (not glass). Notice the phenomena carefully.

When the action stops, hold the lower opening of a Bunsen burner across the mouth of the bottle, having the cover removed as shown in Fig. 90. Notice the yellow color imparted to the flame, which color is characteristic of sodium and its compounds. This test must be applied as soon as the action of the sodium stops.

EXPERIMENT No. 100:

Prepare potassium hydroxid, following the steps exactly as in the preceeding experiment, except that metallic potassium is employed in place of metallic sodium.

The flame, when the Bunsen burner is placed across the mouth of the bottle, in the case of potassium will give a purple color instead of a yellowish color as obtained with sodium. Notice all phenomena, and compare with that of sodium.

$$K + H_2O = KOH + H$$

EXPERIMENT No. 101:

Sodium Hydroxid made from Slaked Lime and Sodium Carbonat.

Put about 7 grams of finely crystallin sodium carbonat (Na_2CO_3) on a piece of paper, and on another paper 5 grams of slaked lime ($Ca(OH)_2$). Pour the two into a beaker and add about 40 cc. of water. Pour the liquid obtained from the beaker into a Florence flask, leaving the flask unstoppered; (Fig. 91). Place it on a ring stand or tripod on asbestos, and boil for four or five minutes. Before completing the boiling add water enough to replace that which evaporates. Filter, and if the solution is so strong as to break the filter, let the mixture settle, decant it, and use the decanted liquid for testing.

Test the filtrat by its action on solutions of Copper chlorid, ($CuCl_2$), Silver chlorid, ($AgCl_3$), and Ferric (Iron) Chlorid, ($FeCl_3$); by its action on red litmus. Note the color effects in each case.

EXPERIMENT No. 102:

Potassium hydroxid made from slaked lime and Potassium Carbonat.

Prepare by similar method as for sodium hydroxid, except that potassium carbonat (K_2CO_3) is employed in place of sodium carbonat.

Compare all the phenomena observed when potassium is used, with those obtained by the action of Sodium carbonat. The product obtained is:

$$Ca(OH)_2 + Na_2CO_3 = CaCO_3 + 2\,NaOH$$
$$Ca(OH)_2 + K_2CO_3 = CaCO_3 + 2\,KOH.$$

EXPERIMENT No. 103:

Electrolytic Preparation of Sodium Hydroxid.

The apparatus shown in Fig. 92 was described in detail in the October 1916 install-

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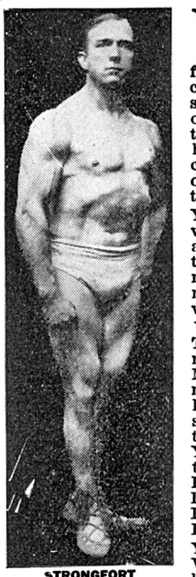

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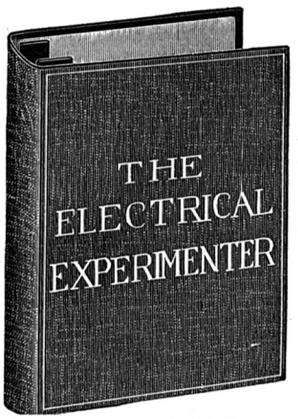

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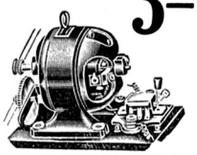

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ment of this series of papers (page 405), and reference is made for a detailed description of this apparatus. Essentially, it consists of a U-tube, fitted with two two-holed rubber stoppers, thru which pass the delivery tubes, and two electrodes, sealed in a piece of glass tubing which contain mercury. The electrodes should be of platinum, as this substance expands and contracts in the same proportion as glass, besides being a better electrode than other substances, it withstands the action of the various solutions much better than copper, nickel, or other electrodes will.

This apparatus may be considered a laboratory modification of the Castner-Kellner method of electrolytic apparatus shown in Fig. 88. The U-tube is filled with mercury so that it extends above the bends of both sides of the tube, which prevents the chlorin liberated from the anode from coming in contact with the sodium hydroxid formed at the cathode. If a little red litmus is added to the salt solution, it will be bleached by the chlorin around the anode, and turned blue by the sodium hydroxid at the cathode. Chlorin is liberated at the anode, and we may assume that sodium is separated for an instant at the cathode, which at once interacts with the water present, liberating hydrogen and forming sodium hydroxid.

The equation of the reaction caused by the electrolysis of the sodium chlorid solution (common table salt) may be represented by the following equation:

$$NaCl + 2H_2O = NaOH + H + Cl$$

AQUA REGIA.

HISTORY:—

This name is given to a mixture of Nitric and Hydrochloric acids which is frequently employed for dissolving gold and platinum, as well as many metallic ores and other substances.

The Alchemists called this mixture *Aqua Regia*, which meant Royal Water or King of Waters, because it possest the power of dissolving Gold, which was considered the king of metals. Aqua Regia was therefore believed to be the strongest solvent known. Any thin liquid they termed *Aqua*, the Latin, meaning water, and affixing some adjective to express the kind of water, as Aqua Pura (Pure Water), Aqua Fortis (Strong Water, which they applied to Nitric acid), etc.

Strictly speaking, Aqua Regia is not an acid, tho it is often so called from its constituents, nitro-hydrochloric acid. It is made by mixing the two acids, Nitric and Hydrochloric,—one volume of the former to three volumes of the latter. A reaction takes place which is variable, depending on the relative amounts and strengths of the two acids. A general reaction is:—

$$3\,HCl + HNO_3 = 2\,H_2O + \underset{\text{Nitrosyl Chlorid}}{NOCl} + Cl_2$$

The solvent power of the Aqua Regia depends upon the fact that, on heating, this mixture of acids evolves Chlorin. In the reaction chlorin is always liberated. When Aqua Regia is employed to dissolve metals, the chlorin liberated, during the reaction forms chlorids, the higher chlorid in case the metal has more than one valence. The action is very vigorous, especially if the liquid is hot. While Gold (Au) and Platinum (Pt) are not affected by hydrochloric acid or Nitric acid, they combine readily with the chlorin to form gold chlorid ($AuCl_3$) and platinum chlorid ($PtCl_4$), which dissolve in the liquid.

As chlorin is one of the strongest of oxidizing agents, either as a gas or in solution, aqua regia will change—ous to—ic salts; as, for example, Mercurous chlorid (HgCl) to Mercuric chlorid ($HgCl_2$), Ferrous chlorid (Iron) chlorid ($FeCl_2$) to Ferric (Iron) Chlorid ($FeCl_3$), etc. It possesses a strong, irritating, characteristic odor, the color varying from orange to red. Owing to the escape of its gases it cannot be kept, but should be made as required for use.

Experiment No. 104.

Hold a test tube in the left hand, nearly on a level with the eye, and pour into it about 6 cc. of hydrochloric acid (HCl), (Fig. 8b in the August, 1916, "Electrical Experimenter"). Add to this about 2 cc. of nitric acid.

Watch the mixture a moment, and if no action can be noticed, bring the tube to a flame for a moment only.

$$3HCl + HNO_3 = 2H_2O + \underset{\text{Nitrosyl Chlorid}}{NOCl} + Cl_2$$

The products are for the most part, chlorin (Cl), Nitrosyl chlorid (NOCl), and Water (H_2O). The mixture is called aqua regia, or nitro-hydrochloric acid, its strength being mainly due to chlorin.

Experiment No. 105.

Put one or two pieces of Zinc into a tube and add a little of the aqua regia. If any gas escapes test its combustibility by applying a lighted splint, also smell the odor, etc.

Put into a dish a few pieces of copper and add a very little aqua regia. After a minute dip a splint into the solution; then hold it in the flame of a Bunsen burner and notice any color effects.

Moisten a glass rod and roll upon one end of it a half sheet of gold leaf. Dip this into a tube containing a small amount of aqua regia, using care not to touch the sides of the tube. Notice the action the instant the gold touches the liquid.

Experiment No. 106.

Ascertain whether gold will dissolve in either hydrochloric or nitric acid, separately, using a clean tube and glass rod, and heating each liquid to the boiling point. (Great care should be exercised in bringing these acids to the boiling point, being careful that the acid does not boil over or spatter on the hands or clothes. If the action becomes too violent immediately remove the tube from the flame.)

If it does not dissolve, pour the contents of each tube together, and notice any action which takes place.

Experiment No. 107.

Ascertain the action of aqua regia on scraps of iron, and note whether the product is the same as when hydrochloric acid acts on iron. Test the result of each action by the use of ammonium hydroxid (NH_4OH), also a splint applied to the mouth of the tube, to determine if a gas is present, etc.

When nitric acid acts as an oxidizing agent, it usually decomposes, as represented in the following equation:

$$2HNO_3 = H_2O + 2NO + 3O$$

If hydrochloric acid is present, the oxygen, as fast as formed, reacts with the acid according to the following equation:

$$6HCl + 3O = 3H_2O + 3Cl_2$$

The nitric oxid formed according to the first equation is not evolved as such, but combines with the chlorin liberated according to the second equation, to form an orange-yellow, gaseous compound known as Nitrosyl chlorid (NOCl).

$$2NO + Cl_2 = 2NOCl$$

By combining these three equations in the regular way and dividing the resulting equation by 2, in order to get its simplest form, one obtains the following:

$$HNO_3 + 3HCl = 2H_2O + \underset{\text{Nitrosyl Chlorid}}{NOCl} + Cl_2$$

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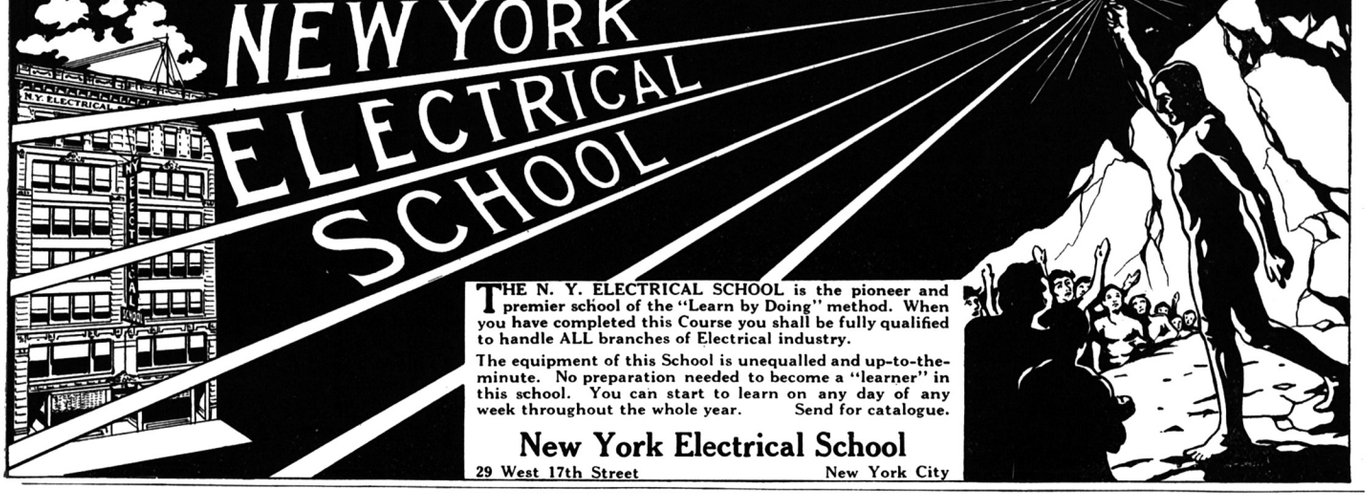

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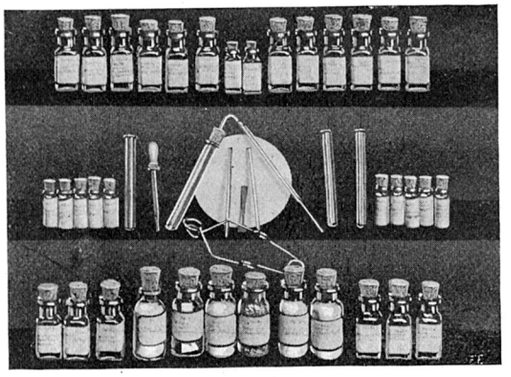

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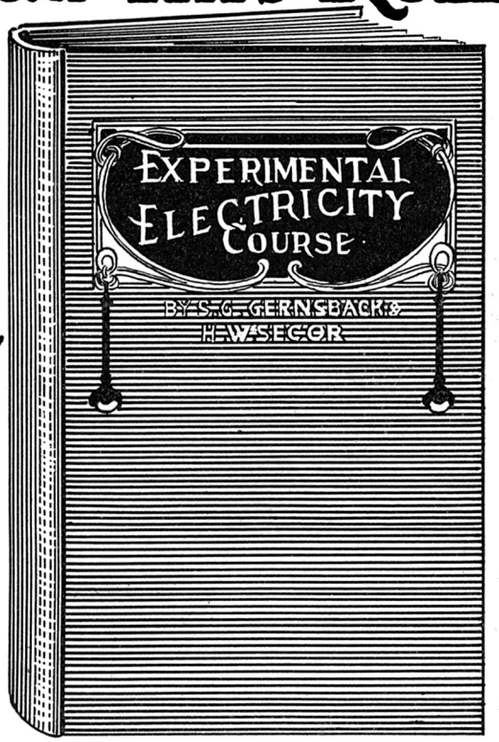

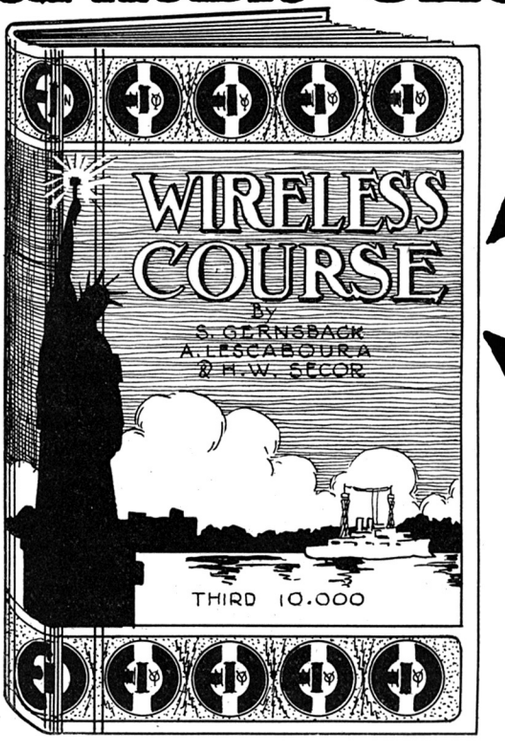

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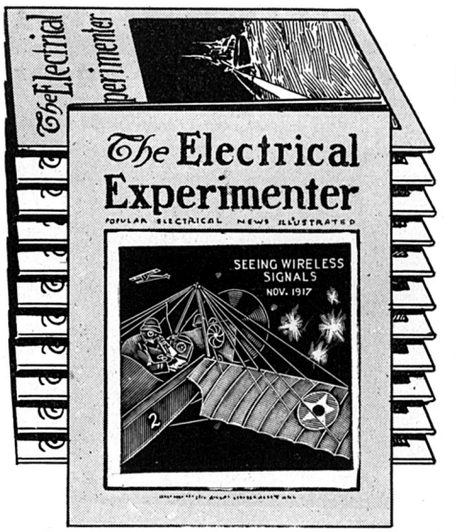

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HISTORIC ELECTRIC APPARATUS.

(*Continued from page* 448)

the year 1810. He did not enclose his incandescent lamp in a vacuum or in a tube however, but contented himself with bringing a strip of platinum 1/30 of an inch thick by 18 inches in length to a high state of brilliance by connecting it to a large number of batteries. Little was done in succeeding years to evolve any form of incandescent electric lamp, and the next we hear of this now universal illuminant is in 1841, when we find the work of de Moleyns. His incandescent lamp utilized a fine platinum wire. About the first incandescent lamp of the exhausted bulb type that we find a record of, is that due to Starr, a Yankee inventor of Cincinnati, Ohio. His first product bears the date of 1845, when he took out a patent for a *carbon filament lamp with an exhausted bulb.* He took out many patents, and evolved a diversified number of incandescent lamps and filaments, but owing to the lack of commercial dynamos, success in those days was of short duration.

Another earnest worker in this field was Henrich Göbel, of New York City, who produced a very promising carbon filament lamp in 1854. Göbel first used wood charcoal for the filament, and later tried carbonized bamboo.

The *Edison incandescent lamp* upon which large sums of money were spent in development for several years, finally emerged from the laboratory in 1879, and from that date progress was real and assured in the development of electric lighting. The illustration in Fig. 7 shows the earliest form of incandescent lamp, and also the Edison lamp as first manufactured. The Edison lamp had an exhausted bulb, and a carbon filament was used composed of carbonized brown paper at first, but shortly afterward this was made of carbonized bamboo. Thousands of different kinds of filament and materials for them were exhaustively tested out in Edison's laboratory, and it is surprising to learn that even in those days there were a number of inventors who proposed *metallic filament* lamps, and actually tried out incandescent lamps, having filaments coated with metallic oxids, etc.

The *arc lamp,* which is very common now-a-days, was invented by Sir Humphrey Davy, who discovered in 1801, that by connecting up a large number of battery cells to a pair of pointed carbon rods, that when these rods were placed in contact and then separated, an electric arc of great brilliance tended to form between the carbons. In 1809, Davy exhibited publicly the first electric arc light, which was excited by *two thousand primary battery cells.* Arc lights languished for a good many years until an Englishman by the name of Wright, in 1844, devised the first successful automatic self-feeding arc lamp. Wright's ingenious automatic arc lamp is shown in Fig. 8, as also Davy's first arc lamp of the hand-feed type.

Wright's arc lamp comprised a series of carbon discs with bevelled edges, arranged in the manner illustrated. Two of these discs were movable; thus making it possible to compensate for the change in the length of the arc as the discs were burnt away, and all of the carbon discs were rotated while the lamp was in operation by means of clock-work mechanism.

The *telephone,* now in use in practically every city and community all over the civilized world, first saw the light of day in Germany (1861) in the apparatus invented by Philip Reis, instructor in natural sciences at Professor Garnier's Institute, a select school for boys at Friedrichsdorf, near Homburg. As Professor Sylvanus P. Thompson has declared—"the apparatus devised by Reis was the employment of a loose or imperfect contact between two parts of a conducting circuit so that the pressure and electrical resistance might be varied by differing stress." By this system (see Fig. 9) Reis was able to transmit musical sounds, especially whistling and other shrill tones, with all variations of pitch and loudness, altho without timbre, probably resembling somewhat the sound of a xylophone (wooden piano)—and less perfectly, also, the sounds of the human voice; the consonants being readily represented, but the vowels less distinctly, if at all.

Referring to this early forerunner of the wonderful telephone which Professor Bell (1876) later perfected so as to be able to transmit articulate speech over any distance by electrical means, we find that Reis used as a transmitter, a small box having two openings, one at the side for the mouthpiece, and the other at the top, closed by a diafram, made from the smaller intestine of a pig. At the center of this membrane was cemented a strip of platinum in loose contact with the point of a platinum wire held in position above it by a light leaf spring. The receiver of the Reis system comprised a steel wire, wrapt around with a coil of insulated wire, thus forming an electro-magnet. This was mounted on a small resonant wooden box resembling a violin, and which served as a sounding board. To this was later added a cover of thin wood, against which the ear could be prest to receive the sounds transferred along the wire electrically from the transmitter.

Wireless telegraphy for practical purposes really dates back to the brilliant scientific researches of Henrich Hertz. Many electrical writers date wireless telegraphy back to the first wireless transmission of messages to 1838 when Professor Joseph Henry, of Princeton University, succeeded in setting up induced currents in the cellar of a building, when a Leyden jar was charged and discharged by means of a static electrical machine placed in the top room of his residence. Next in line to be credited by many writers is Professor S. F. B. Morse, who is stated by one authority ("Wireless Telegraphy," by Sewall, 1904) to have actually sent the *first signal without wires* on December 16th, 1842, when he succeeded in sending a wireless telegram across a canal 80 feet in width, and in November, 1844, Mr. A. D. Gale, under the instruction of Professor Morse, transmitted wireless signals across the Susquehanna River at Havre de Grâce, a distance of nearly one mile.

This wireless scheme, however, was based on the principle of *conduction,* and thus was limited in its application and in the range that could be covered. Considerable experiment was done with *inductive* systems of wireless telegraphy and telephony, in America, from 1882 to 1885 by Professor Dolbear and Thomas A. Edison, the latter investigator having successfully signaled thru space to a moving train from a wire installed on poles beside the railway, in 1885.

The crowning achievement in the realm of radio-telegraphy by *etheric wave* transmission was that of Hertz, in 1886. Across a small spark gap in a ring of wire suspended in a room (there having been no electrical contact with the charging apparatus), Hertz caused tiny sparks to appear as the result of the passage across another and longer spark gap of the oscillatory discharge from a Leyden jar. Finally we come to the work of Guglielmo Marconi,

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RADIO ROLL OF HONOR.

(*Continued from page* 462)

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(*Continued from page* 479)

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THE WORLD AFTER THE WAR.

By a Teuton Scientist.

What will the world be like after the war? A German scientist's imaginative after-war picture is the feature of the latest number of the German review, *Zukunft.* The author, Professor Moritz Lesser, is a member of the faculty of engineering of the University of Bonn. The professor pictures, in fanciful style, a world at peace, in friendly and international relationship making use of the technical discoveries which have been made during the war for the development of commercial enterprise. The article in part is as follows:

"Three months after the end of the war, the directors of the leading banks and corporations of Germany held a meeting to the number of 3,000 in the Reichstag, with the home secretary for chairman, and founded a company 'For the Development and Use of Inventions Discovered During the War.' The object of the company was to employ in peace the technical progress which had been accomplished under the stress of war, and the capital subscribed was 40 times as great as required.

"One object of the company was to build submarines for pleasure trips and to search for treasures lost during the war.

"It was found possible to build a submarine which sank to a depth of more than a mile, and from this sprang the international company for raising the ships sunk during the war. The work was an immense success, and large sums of money were made from this salvage work. There was also huge profit in taking passengers in these ships for trips of exploration and sightseeing along the bottom of the sea. Ships were found which had gone down centuries ago, and one expedition recovered the treasure of a whole continent which was sunk in a Spanish Armada. Moreover, rich veins of coal and iron and other minerals were discovered in the sea.

"Meanwhile wireless telegraphy was perfected until it was possible to send a current around the entire world. It was also possible to supply airships with the current. A company was founded for a passenger and parcel service without gasoline which began serving all important parts of the world.

"At the same time the Peace Conference at The Hague, which represented all civilized nations, decided on the complete disarmament of all the world, without any restrictions. By this time every great Power had established a fleet of unmanned aeroplanes loaded with thousands of bombs, which were to release by wireless current at the first mobilization of the enemy over all his important towns. In this way every hostile town and base would be reduced to ruin in a few hours. This meant that there could no longer be any war."

Other imaginary inventions described by the writer include an American "spectral film," which brought the pictures of distant events as they happened to the theatre and private house. Another invention dispensed with the use of coal and gas by preserving the heat and light of the sun. Traffic problems in the world's great cities were solved by setting pavements and streets in motion. The article concludes:

"Finally, as inventions reduced the trouble of living more and more, the people began to lose the use of their limbs, since everything was done for them, a world conference was assembled, which forbade anyone inventing anything more." *Sic temper gloria mundi.*

LOCATING UNDERGROUND ORES BY ELECTRICITY.

(*Continued from page* 441)

about the center of the primary coil, the magnetic field will be weakened, but the contour lines are not distorted from their normal circular form. However, with a sufficient number of sets of contours, the presence of the conducting orebody is positively determined.

If the conductor be close to the surface, or nearly in the plane of the primary coil, the galvanometer shows a minimum reading when the same amount of magnetic flux is inclosed by both exploring coils, but this minimum reading is not zero, since some current will flow between the exploring coils, probably due to a difference in phase caused by the angle between the lines of force in the two magnetic fields.

The presence of water courses, puddles on the surface or solutions in the ground does not affect this method, since liquids are not appreciably conductive of the low-voltage oscillating current that is induced. Contour lines about any given center can be practically duplicated at any time, regardless of the weather conditions or variations in ground water.

Theoretically, the presence of a conductor within a distance from the plane of the primary coil, of two-thirds the diameter of the primary coil, will measurably affect the magnetic flux in the plane of the coil. This has been proved practically, so that if the primary coil is 200 ft. in diameter, a conductor within 130 ft. of the surface or, if the primary coil is 400 ft. in diameter, a conductor within 260 ft. of the surface, will cause distortion of the contour lines.

The field development of this method was carried out in the Joplin district, Missouri. Of the ores found in this district—namely, zinc blende, galena and pyrite—the zinc blende is not a conductor and cannot be determined, but the galena and pyrite may be determined satisfactorily. Both galena and pyrite are conductors, and as this electrical method does not distinguish the quality of the conductor, drilling is necessary after determining the orebody electrically for identifying the mineral by drill cuttings. This disadvantage is somewhat offset by the fact that all three minerals are ofen closely associated, so that the electrical determination of an orebody consists of either galena or pyrite may incidentally, by drilling, develop an orebody of blende.

In order to operate with efficiency, an automobile truck has been equipped with self-exciting alternating-current generator, driven by a gasoline engine, and all instruments and machinery required for producing the high-frequency oscillating magnetic field are mounted in the truck body. An instrument box containing galvanometer, current rectifiers and switches is provided for convenience and portability when exploring the magnetic field to determine the contour lines. Portable reels carry the necessary wires. The entire equipment may be placed in the truck for moving.

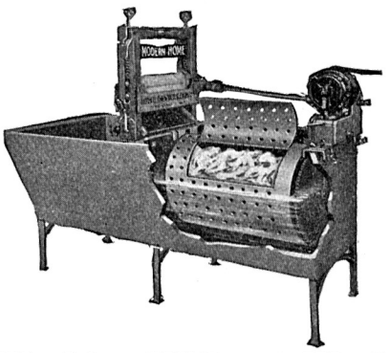
For prospecting in any mineralized district, the first requirement is the tabulation of all ores liable to be found in that district, with their degrees of conductivity. I have been unable to find any record of work done toward such a tabulation of ores. A partial list of minerals, with their comparative degrees of conductivity, has been determined for this work, as shown in the accompanying table.

COMPARATIVE ELECTRICAL CONDUCTIVITY OF MINERALS

Proustite	18
Cerargyrite	0
Pyrargyrite	20
Bromirite	0
Chalcocite	115

MODERN HOME WASHER

"FITS IN ANY TUB"



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The machine washes delicate laces and lingerie without injury; also heavy blankets and small rugs. Clothes washed in it last six times as long as those washed on the rubbing board or at laundries.

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Hand Power, Stationary Tub Type..... 15.00

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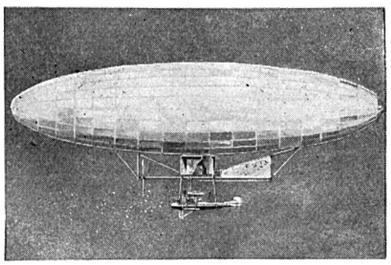

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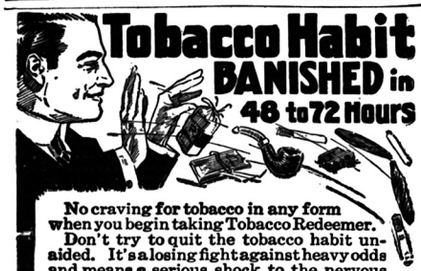

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No craving for tobacco in any form when you begin taking Tobacco Redeemer.

Don't try to quit the tobacco habit unaided. It's a losing fight against heavy odds and means a serious shock to the nervous system. Let the tobacco habit quit YOU. It will quit you, if you will just take Tobacco Redeemer, according to directions for two or three days. It is a most marvelously quick and thoroughly reliable remedy for the tobacco habit.

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Make your Row Boat an Electric Launch. Buy a Jewel Detachable Row Boat Motor run by electricity. No odor or dangerous gasoline. Simple, noiseless and powerful. Attaches to any Row Boat and runs on two six volt Batteries. This is our 5th successful year.

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Look inside your storage battery through the patented open window. See condition of plates and height of electrolyte. If you need a new automobile starting Battery buy a Jewel and save money. 6-60 Special $8.50.

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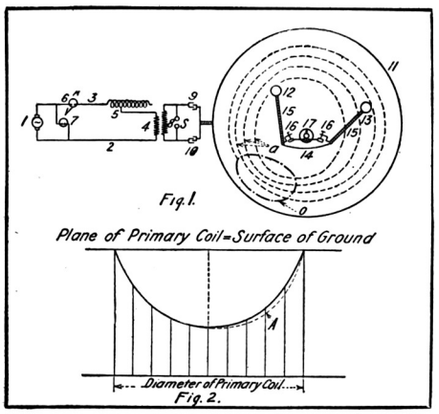
The Jewel Generator Motorcycle Storage Battery and complete lighting system is in great demand. **Agents wanted. Write for prices and catalog E.**

JEWEL ELECTRIC COMPANY, 112 N. Fifth Av., CHICAGO

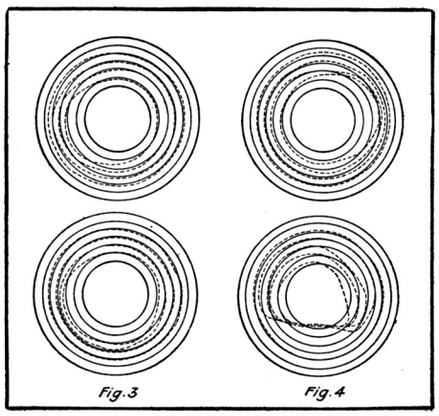
Chalcopyrite	115
Enargite	110
Tetrahedrite	110
Malachite	0
Chrysocolla	0
Cuprite	0
Tenorite	0
Azurite	0



Arrangement of Electrical Prospecting Apparatus and Plot of the Magnetic Field.

Atacamite	0
Galena	105
Jamesonite	40
Boulangerite	90
Zinkite	115
Blende	0
Hydrozincite	0
Calamine	0
Smithsonite	0
Willemite	0
Magnetite	120
Specular Hematite	50
Pyrite	110
Red Hematite	0
Limonite	0
Pyrolusite	115
Psilomelane	0
Manganite	0
Braunite	0
Hausmanite	0
Rhodonite	0

The main difficulties, in the district where the method was developed, are the frequent occurrence of pyrite, which is of no value, and the nonconductivity of zinc blende, which is the most desirable ore. The Joplin district, however, has proved a most advantageous place for the development of this method, since the ore-bodies are generally less than 200 ft. below the surface, and facilities for experimental work are ample and convenient. Field experiments have been carried on for over a year. Of eleven locations tested by drilling, after the electrical observations had indicated a



Actual Distorted Contour Lines Obtained in the Field. The Dotted Areas Result From, and Indicate the Presence of an Ore-Body.

conductor, seven proved the presence of the conductor, six cases being pyrite and one case galena. The four locations not proved by drilling occurred in the early part of the work, before enough data had been accumulated to assure proper interpretation of the contour lines.

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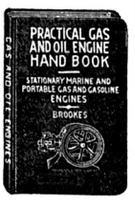
Automobile Mechanician's Catechism and Repair Manual (Leather) $1.25.



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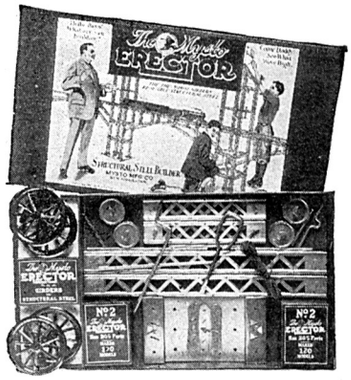

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FOR EXCHANGE—My complete wireless receiving set, value about $60, for a Smith Motorwheel in good condition. G. M. Burchnell, Monroeville, Ind.

WILL SELL—Colonial 110 direct, three-speed fan, $4. 6-18-volt Menominee Motor, $3. Marconi 2-inch Transformer Coil, $3.50. Terms c. o. d. express. Robert Haag, Chadwick, Ill.

FOR SALE—Wireless instruments at bargain. Send red stamp for list and prices. W. F. Wentling, Cumberland Valley, Pa.

WILL PAY CASH for $18 Omnigraph and dials, if in good shape. Edward Law, Jr., 216 Sycamore St., Clarksburg, W. Va.

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BARGAINS—Seneca Camera 2¼x3¼ R.R. lens trio shutter and outfit, $10. Cub camera 3¼x3¼, $1. Ernest Rerucha, Brainard, Nebr.

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WANTED—Motorcycle, light weight Indian preferred; must be in A-1 condition, no junk wanted. Also want motorbike, carbide generator, omnigraph and vibroplex. Have $6 toy picture machine for $3. O. C. Miller, Bayard, Kansas.

FOR SALE—4,000 M. Loose Coupler, $4, cost $10; Brandes 2,000 ohm head-set, $3; 1/20 H.P. Knapp A.C. motor, $3.50; Knapp Type S Dynamo Motor, $1.50; 1" Coil, $2. Write for further particulars. All letters answered. Ray J. Farmer, Monteguma, Iowa.

COMPLETE I. C. S. Electrical Engineering Course, Cost $145. Never been used. Will sell half price. Swap for Saxaphone. George Niman, Polo, Ill.

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FOR SALE—Carlisle & Finche Electric Motor. Good condition. Price $10. Earl Cook, Bernardston, Mass.

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SELL—Navy coupler; Perikon detector; variometer; ¾" spark coil; $5 Erector; Encyclopaedia Britannica. Write for list. Carlton Caswell, Franklin St., Framingham, Mass.

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WANT—½ to 1 H.P. 500 volt motor or generator, Weston or Keystone portable ammeter 0-50 amperes, voltmeter 0-150 volts. Will buy for cash or exchange for radio apparatus. Have an excellent Keystone milliampere meter; fine for research work. Samuel Cohen, 1936 Pitkin Ave., Brooklyn, N. Y.

SACRIFICE—Wireless apparatus, Tesla coil, camera, books, copies of E. E., Steffey bicycle motor. Write for immediate offer. Stamp, Norman Himes, Norwich, Conn.

FOR SALE CHEAP—Wireless and Electrical apparatus. Want taps and dies. James Dickerman, 20 Rush St., Somerville, Mass.

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FOR SALE—One 2½ horse power Shaw bicycle motor, run less than one hundred miles, good as new; it has a high tension magneto. Also have for sale one Henderson motorcycle, 1914 model, 15 horse power, no magneto. Will sell the Shaw motor for $30, and the Henderson for $35, it is all complete but the magneto. Henry Michelsen, Gladbrook, Iowa.

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FOR SALE—Duck's Navy Type Receiving Transformer, 2,500 meters, cost $19.50, sell $12. Murdock 366 43 plate Condenser, $3. Brandes 2,000 ohm receivers, $3. 1 K.W. Aerial Switch, $2. All used one month. Will sell all for $15. Lloyd Ross, R6, Albert Lea, Minn.

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ROLL top desk, single pedestal; York snare drum; Powers' No. 6 motion picture machine; Edison "B" Mechanism; automatic stereopticon, capacity eighteen slides; twenty sets colored song slides; E. I. 3,000 ohm phones, $2.95; offers considered. Good visible typewriter, $25. Verner Hicks, Marion, Ill.

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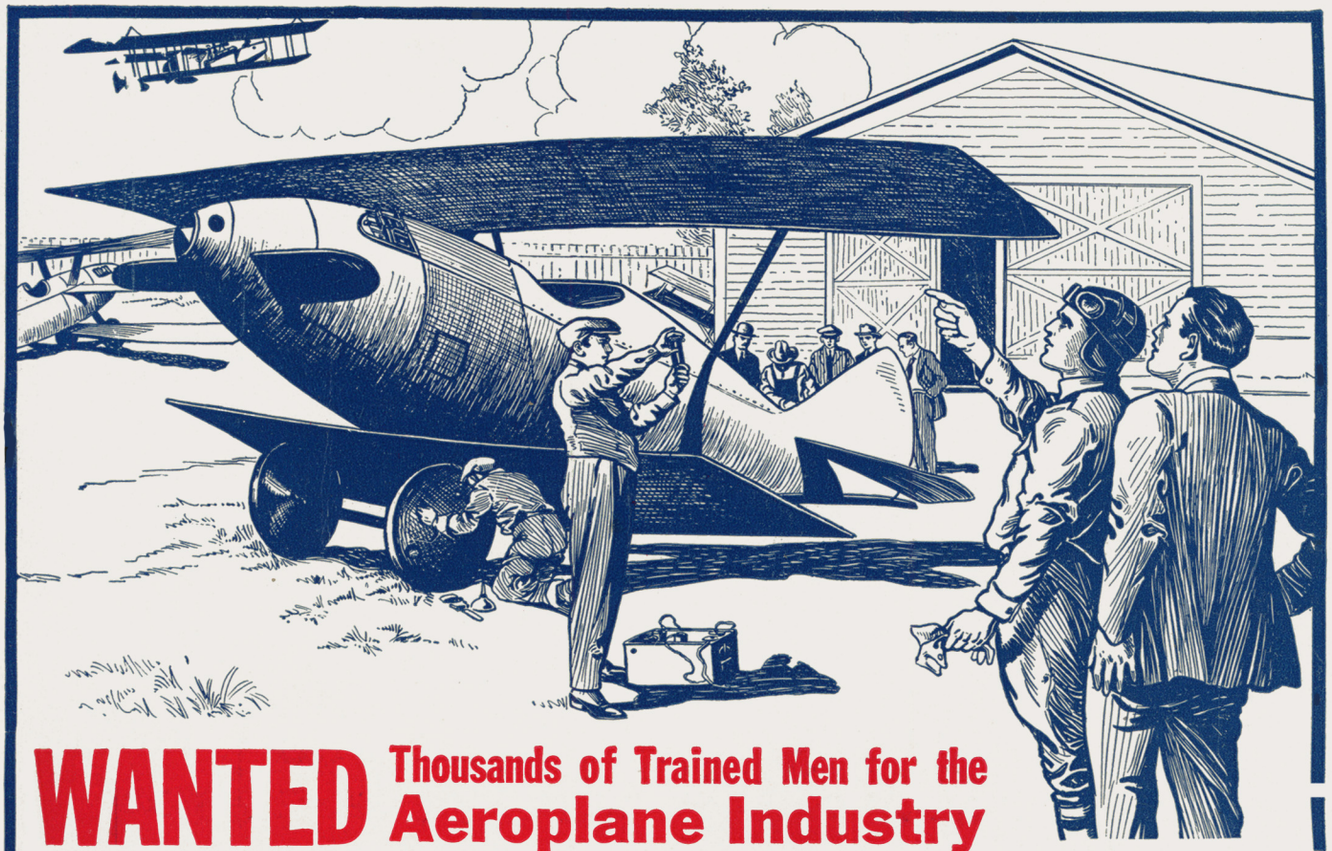

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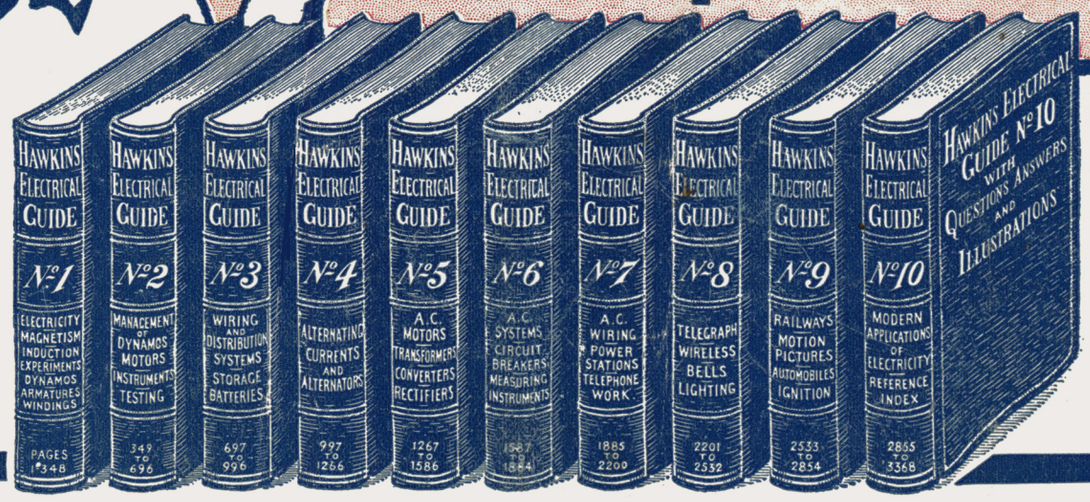
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